Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

May, 1944

EMPIRE BUILDING
CHNOLOGY DEPT:

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e U. S. War
nd Stamps

FIRST
on the "ROLL CALL"...

It's the men who are *rollin' with Lewis* that rate first when it comes to tonnage and quality of finish. They're setting records which back up the steel needs of our armed forces everywhere.

ARMY E NAVY

Also manufacturers of
ROLLING MILL MACHINERY
for the iron, steel and non-ferrous industries

LEWIS FOUNDRY & MACHINE DIVISION of Blaw-Knox Co.
P. O. Box 1586, Pittsburgh, Pa.

LEWIS ROLLS

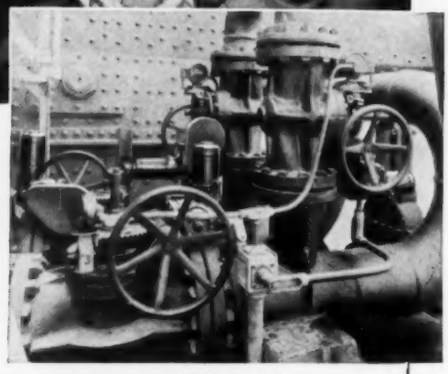
CUTLER-HAMMER

MOTORIZED VALVE OPERATORS

for better process control and plant operation . . .

Do you have valves too large, too hot, too "sticky," too hard to reach for efficient operation by hand? Do you need a simple, better or entirely automatic means of controlling valves in complex refining or chemical processes? Do you want instant operation of valves that are yards—or miles—apart? Do you want to conserve time and man-power in your plant? Or are you looking for valve control that not only *starts* any valve but will seat it safely with *positive protection* to *seat, gate, stem and mechanism*?

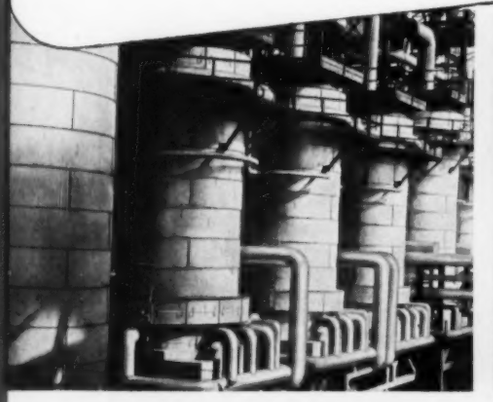
You will find what you want in the Cutler-Hammer Line of Motorized Valve Operators. You will find further, that in choosing Cutler-Hammer Valve Operators for the vast majority of installations, their purchasers are simply recognizing the overwhelming importance of dependability and superior engineering . . . the qualities that have always distinguished Cutler-Hammer design. CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate*: Canadian Cutler-Hammer Ltd., Toronto, Ont.



TO CUT BATCHES SHARPLY AND REDUCE CONTAMINATION IN PIPELINE OPERATION

212 Cutler-Hammer Valve Operators on the "Little Inch" pipeline from Texas to New Jersey, uncounted hundreds on other lines, indicate the importance of rapid, fully automatic and centralized control of valves in modern pipeline practice. It gives protection to product quality obtainable by no other means.

CUTLER-HAMMER
VALVE CONTROL
C-H

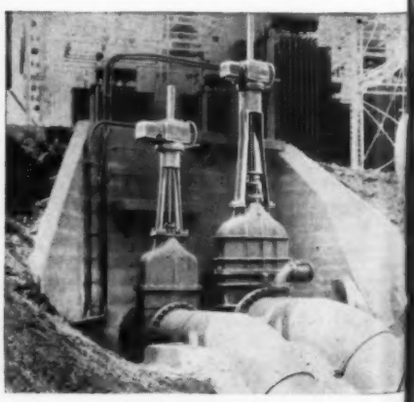


FOR SIMPLE, PRECISE CONTROL IN COMPLEX PROCESS INDUSTRIES

The widespread use of Cutler-Hammer Valve Control in high octane refining processes and other chemical process industries demonstrates the gains that result from fully automatic, often inter-locked sequence control of valves.

WHERE MEN CAN'T GO WHAT MEN CAN'T DO

High pressure, high temperature steam lines and valves often glow red . . . too hot to handle . . . too hard to turn. C-H controlled-thrust-seating operators operate these valves at the touch of a conveniently located push button . . . without danger of jamming.



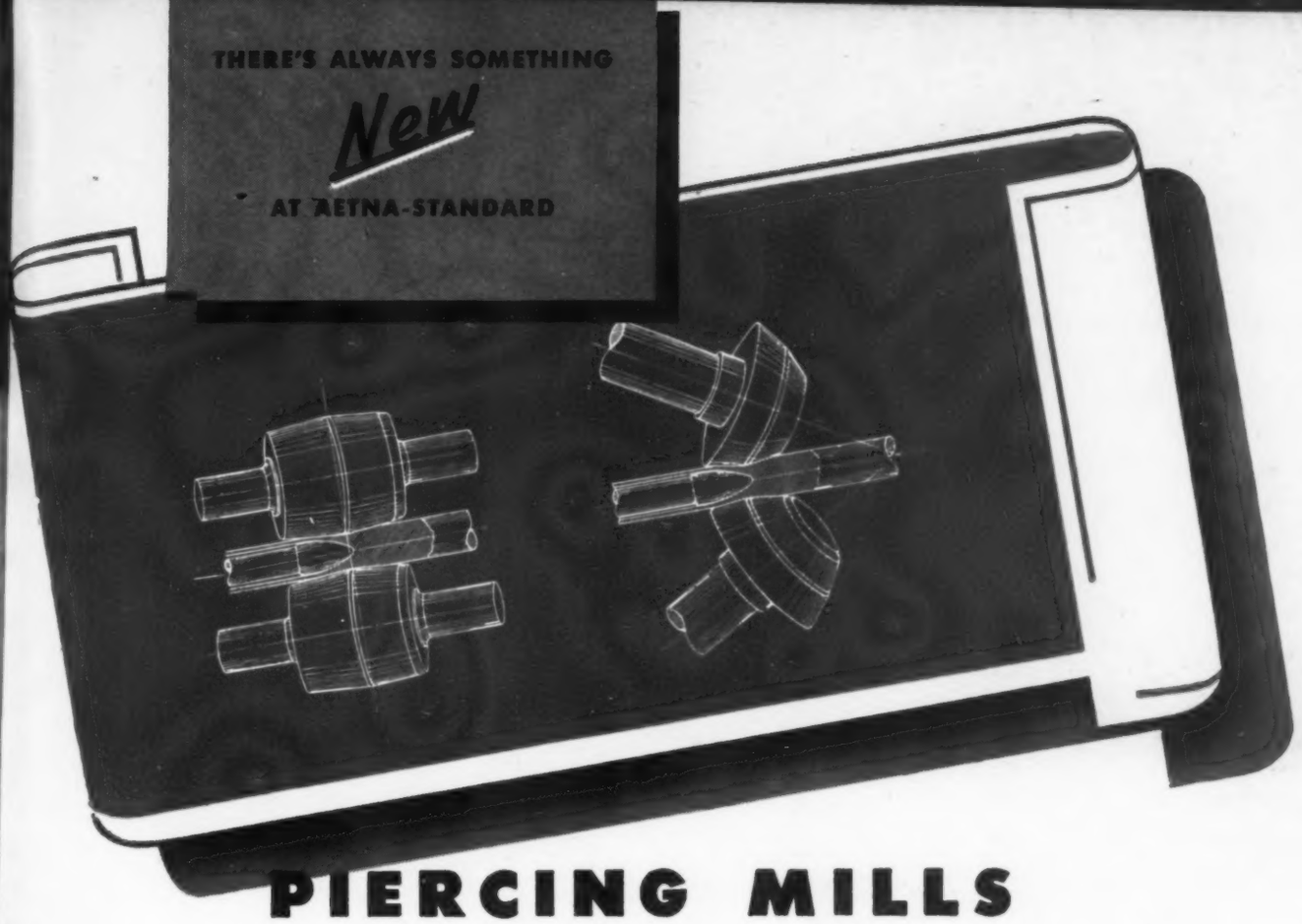
TO OPERATE A VALVE IN THE NEXT COUNTY *NOW*

Distance means nothing to Cutler-Hammer Valve Control. The operation of any valve or any number of valves in the next room, on the next floor or miles away is immediate, certain, easy . . . a matter of pushing a button located wherever convenience dictates.

THERE'S ALWAYS SOMETHING

New

AT AETNA-STANDARD



PIERCING MILLS

For Piercing Ferrous or Non-Ferrous Billets into Tubes from 3" to 18"

Aetna-Standard, in the past 40 years, has built more piercing mills than all other companies combined. In fact, 90% or more of all piercing mills have been Aetna-made. As a result, we have had more experience with this type of equipment than any other concern.

And the margin of difference between a sound piercing mill installation and a poor one is experience . . . For instance, the application of the proper speed and power to the different materials and products is most important.

From Aetna-Standard you can buy a complete seamless tube mill or any unit such as the piercer, plug mill, reelers, sizing mill, or reducing mill. We build all sizes of mills, large and small, with power units ranging between 500 and 5,000 Horsepower, and roll diameters from 19" to 54".

The AETNA-STANDARD ENGINEERING COMPANY

YOUNGSTOWN · OHIO · U.S.A.

ARMY E NAVY

FACTS ABOUT AETNA-STANDARD

Aetna-Standard can furnish either the barrel or cone type of piercing mill. Depending upon the product, we will lay out your tube mill for either single or double piercing.

DESIGNERS AND BUILDERS TO THE STEEL, NON-FERROUS AND CHEMICAL INDUSTRIES

ASSOCIATED COMPANIES:

HEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND

JOHN INGLIS COMPANY, LIMITED, TORONTO, ONTARIO, CANADA

WEAN EQUIPMENT
FOR THE CONTINUOUS COATING OF STRIP STEEL

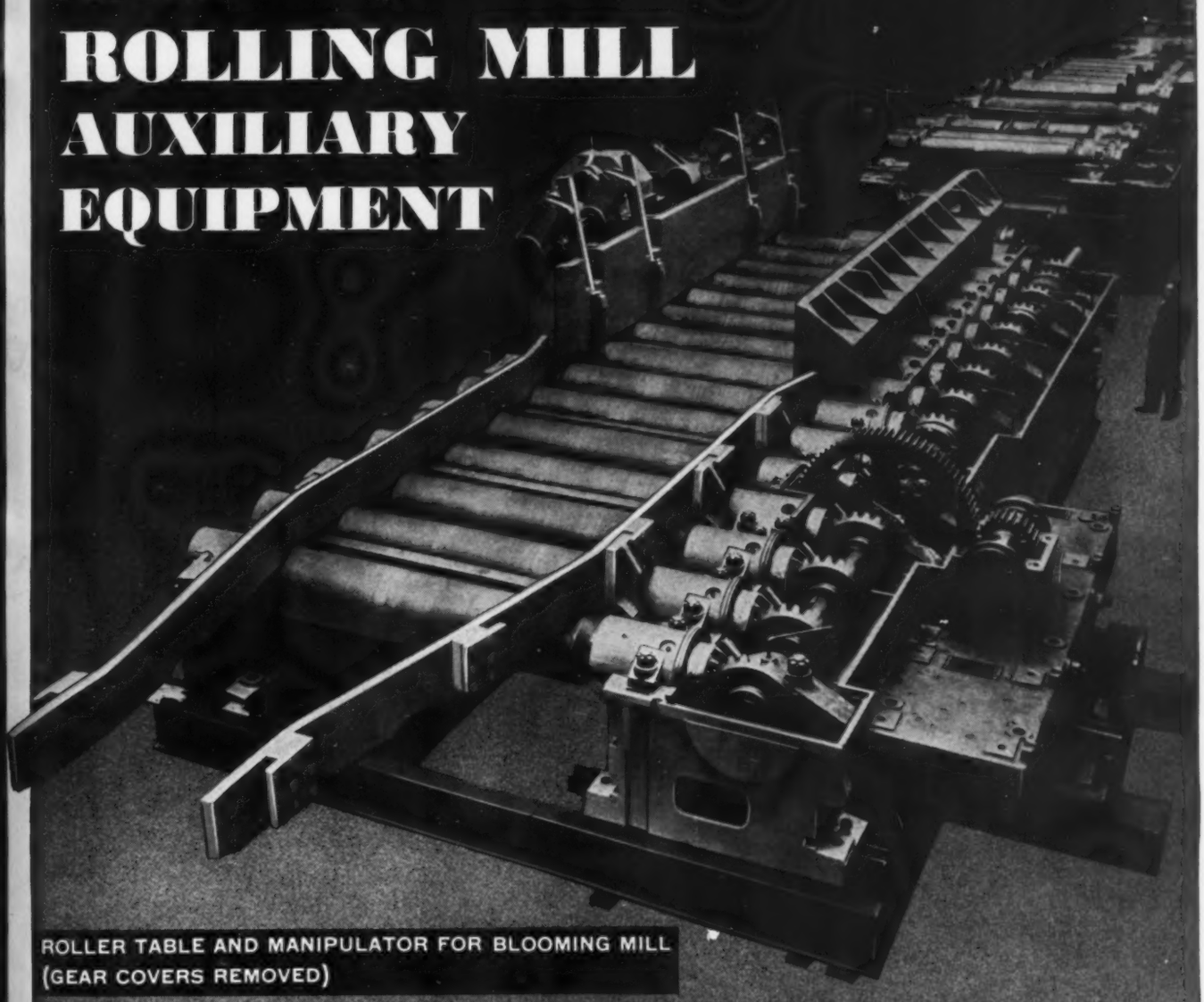
THE Wean Engineering Company is meeting today's demand for equipment to produce tin plate and zinc coated strip steel with light coatings by the electrolytic method; also equipment to produce chemically treated black plate and strip steel. Equipment for coating strip steel with zinc and other materials by the hot dip method is also available.

The WEAN ENGINEERING COMPANY, Inc.
Warren, Ohio

Subsidiary Company
THE BRODEN CONSTRUCTION CO.
CLEVELAND, OHIO

SPECIALISTS IN SHEET, TIN AND STRIP MILL EQUIPMENT

WE BUILD ROLLING MILLS AND ROLLING MILL AUXILIARY EQUIPMENT



ROLLER TABLE AND MANIPULATOR FOR BLOOMING MILL
(GEAR COVERS REMOVED)

HYDROPRESS · INC.

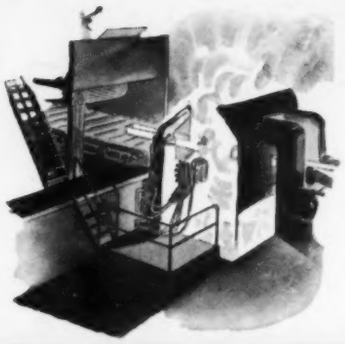
ENGINEERS *CONTRACTORS*

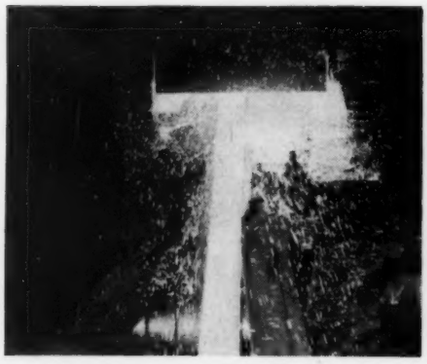
HYDRAULIC PRESSES · ROLLING MILLS
STRETCHERS · PUMPS · ACCUMULATORS

570 LEXINGTON AVENUE · NEW YORK · N. Y.

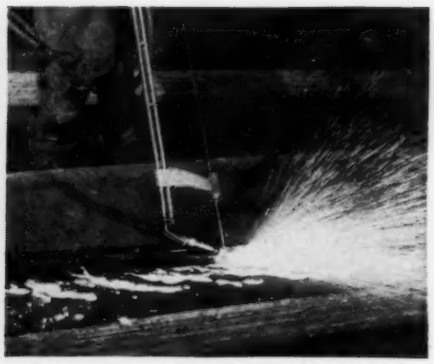
Some LINDE Methods Which Speed Work and Lower Costs

in Steel Mills and Foundries

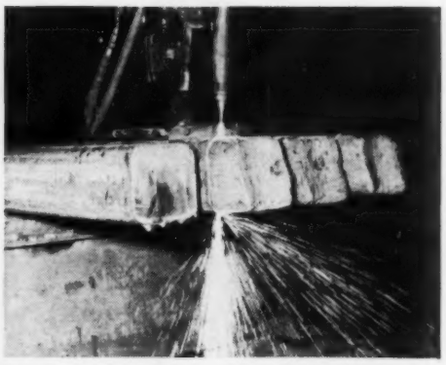




Mechanized Conditioning— Slabs, blooms, and billets are freed of surface defects over their entire area by means of oxy-acetylene machines installed on the roll table. Productive yield is thus increased.

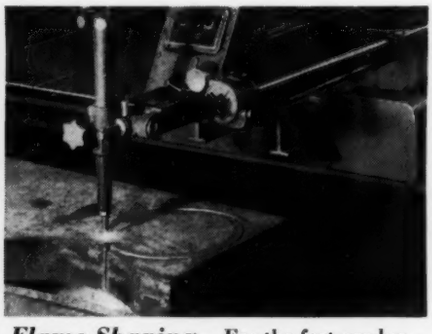


Hand-Deseaming—Where mechanized conditioning of steel is not feasible, or for use in secondary conditioning, oxy-acetylene deseaming with manually operated Oxweld equipment is a quick, economical, and effective method.



Bar and Billet Cutoff—Oxweld flame-cutting machines, both portable and stationary, tremendously speed up and lower the costs of cutting off such parts as shell rounds, forging blanks, disks, and etch test specimens.

Billet-Centering—To facilitate the starting of piercing bars in the manufacture of seamless tubing, this oxy-acetylene method is being used both with hand equipment, as shown, and with mechanized setups.



Flame-Shaping—For the fast production of simple or intricate shapes — for straight-line cutting — for cutting circles, disks, and gear blanks — and for plate-edge preparation — a complete line of Oxweld flame-cutting machines has been developed.

Flame-Descaling — This method is generally faster and more economical than pickling, sand-blasting, wire brushing, and grinding for the removal of mill scale and other undesirable encrustations from steel.

Oxygen, Acetylene, Carbide—A booklet that describes briefly the use of Linde oxygen, Prest-O-Lite acetylene, Union Carbide, and Oxweld apparatus in a variety of Linde processes will be sent without charge on request. Ask for P-13477.

BUY UNITED STATES WAR BONDS AND STAMPS

The Linde Air Products Company

Unit of Union Carbide and Carbon Corporation

UCC

General Office: 30 E. 42nd St., New York 17, N. Y.

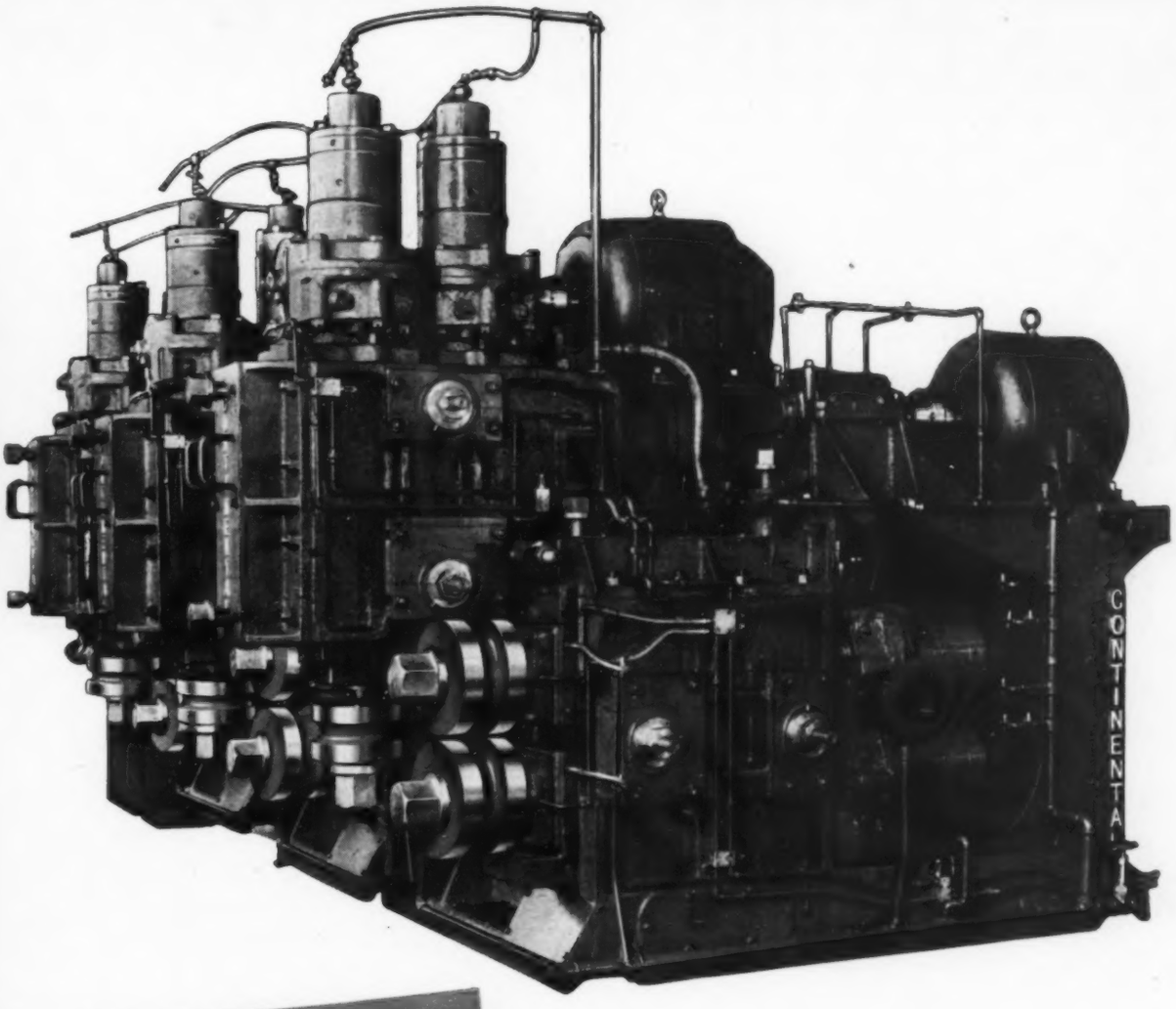
Offices in Other Principal Cities

In Canada: Dominion Oxygen Company, Limited, Toronto

MARITIME "M" AWARD FOR OUTSTANDING PRODUCTION ACHIEVEMENT

LINDE OXYGEN . . . PREST-O-LITE ACETYLENE . . . UNION CARBIDE
OXWELD, PUROX, PREST-O-WELD APPARATUS . . . OXWELD SUPPLIES

The words "Linde," "Prest-O-Lite," "Union," "Oxweld," "Purox," and "Prest-O-Weld" are trade-marks.



CONTINENTAL Continuous Weld TUBE MILL

Manufacturers of Carbon and Alloy Steel Castings, Rolls, Rolling Mill Equipment, Complete Mills and Special Heavy Machinery.

Special design of Continental Continuous Weld Tube Mills permits rolling of tubes with uniform wall thickness.

A sturdier, smoother operating and better controlled mill for producing pipe up to 4" diameter in continuous lengths from coiled strip.

The economical way to produce butt weld pipe in all standard wall thicknesses and in any desired length at 90 to 300 feet per minute.

Individual motors for each pair of rolls, directly connected without the use of spindles—no need for matching diameters of rolls for various stands.

Quick, accessible adjustment for horizontal, vertical and longitudinal movement of each roll.

CONTINENTAL FOUNDRY & MACHINE COMPANY

(FORMERLY CONTINENTAL ROLL & STEEL FOUNDRY COMPANY)

CHICAGO • PITTSBURGH

Why Alliance Cranes Last So Long

1 Working parts accessible for easy, quick maintenance.

2 No out-of-square cranes or girder twists.

3 Sealed lubrication on roller and brass bearings.

4 Liberal safety factors . . . girders, ropes, bearings, gearing, and motor sizes.

5 One-piece trolley frames.

6 Operation easily and accurately controlled.

● Many mechanical crane features accepted as conventional today, were original with Alliance . . . replaceable bronze bearings, all-steel construction cranes including cast steel drums, new system of reeving ropes for ladle cranes, and many others.

When Alliance contracts to build a crane, we visit your plant and survey the property so that we can dovetail the crane into your manufacturing facilities. Never has there been a time when the reward for this service has been greater or the need more eminent.

When "Conversion Time" comes to your plant, your Alliance Crane will still be available for years of service, but you may have to move it from one place to another. In making such change-overs, our engineers will be glad to help you . . . upon request.

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET CHARGING CRANES • OPEN HEARTH CHARGING MACHINES

Alliance

ARMY E NAVY

THE ALLIANCE MACHINE COMPANY • ALLIANCE, OHIO

PITTSBURGH OFFICE: 1622 OLIVER BUILDING

★ ★ WAGNER PRODUCTS FOR VICTORY ★ ★

Wagner Unit Substations are doing their part in the production of steel, synthetic rubber, oil and other vital materials.

Wagner
UNIT SUBSTATIONS
PROVIDE LOAD CENTER CONTROL FOR LIGHTING AND POWER CIRCUITS

The Unit illustrated above is installed in a synthetic rubber plant. Each transformer has a two-position liquid-filled disconnecting switch on the high-voltage side which is equipped with low-voltage interlock. The low-voltage side is equipped with air circuit breakers electrically or manually operated, ground indication lights, voltmeters, ammeters, and ammeter test blocks. Each unit has one main breaker, one tie transfer breaker, and two feeder breakers.

MOTORS
TRANSFORMERS
UNIT SUBSTATIONS
INDUSTRIAL BRAKES
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For Complete Information on Wagner Unit Substations write or phone the nearest Wagner branch office.

BACK THE ATTACK—
BUY U. S. WAR BONDS

NATIONAL SECURITY AWARD

T44-3

Wagner Electric Corporation
ESTABLISHED 1891
6483 Plymouth Avenue, St. Louis 14, Mo., U. S. A.
ELECTRICAL AND AUTOMOTIVE PRODUCTS

UNITED

HEAVY DUTY ROLL LATHES

Headstock Faceplate Directly Driven by "CONE WORM" Gears

Advantages

1. **Operation at a Steady, Uniform Speed—"CHATTERLESS"**
2. **Cone Worm Drive Permits Compact Construction**
3. **Low Head Room—Facilitates Entry of Roll**
4. **Motors Protected by Headstock**
5. **Cone Worm Drive Rated Conservatively**

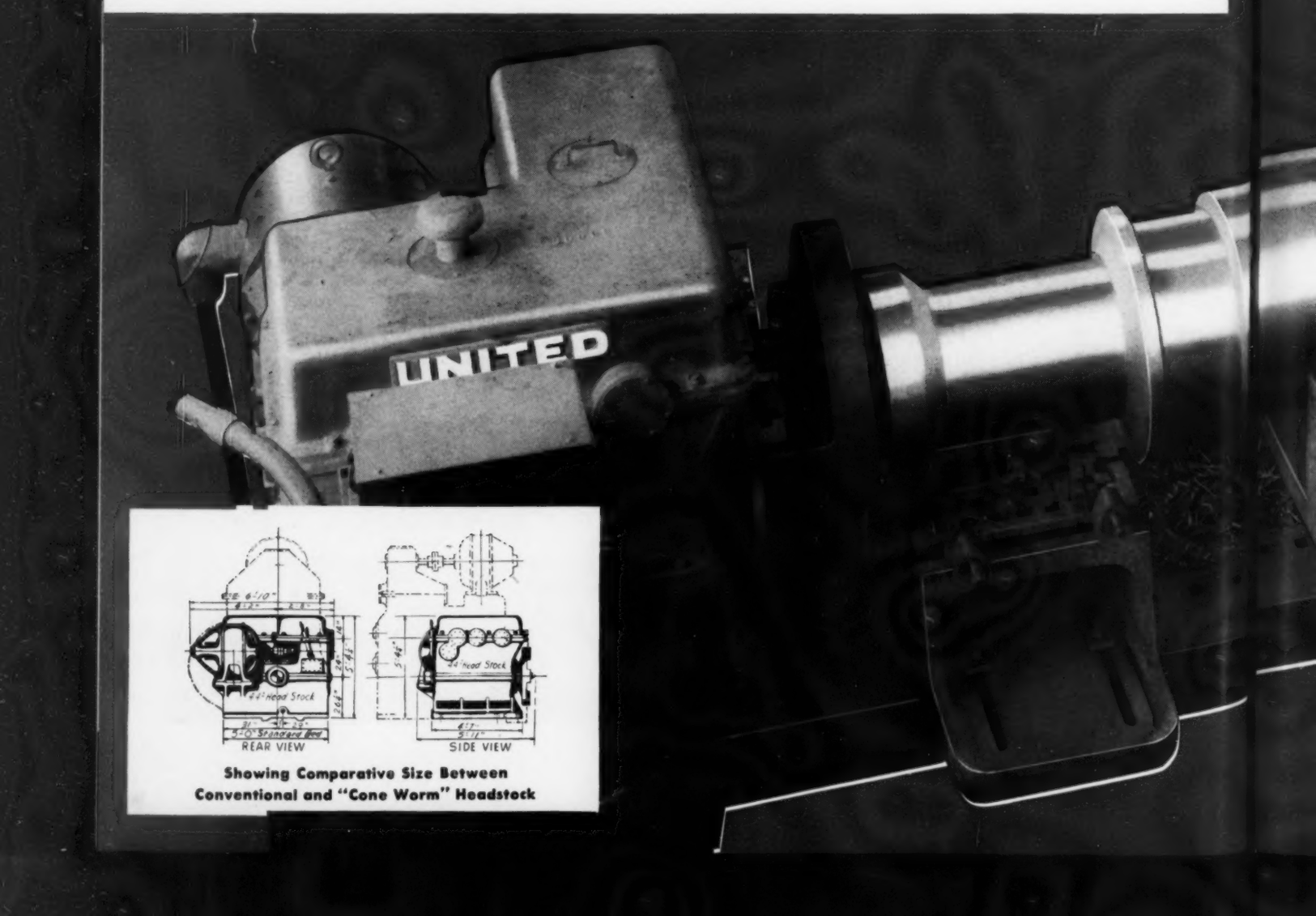
The "Cone" type of worm gearing used in UNITED HEAVY-DUTY ROLL LATHES, with its hour-glass shape of worm partially "wrapping" the gear and thus bringing more teeth in constant contact, provides maximum capacity in the smallest space, and chatterless operation. This superiority has been definitely established by test and experience in UNITED 4-high mill screwdown applications.

Low head room facilitates crane handling of rolls, and compact construction permits more floor space and visibility between lathes.

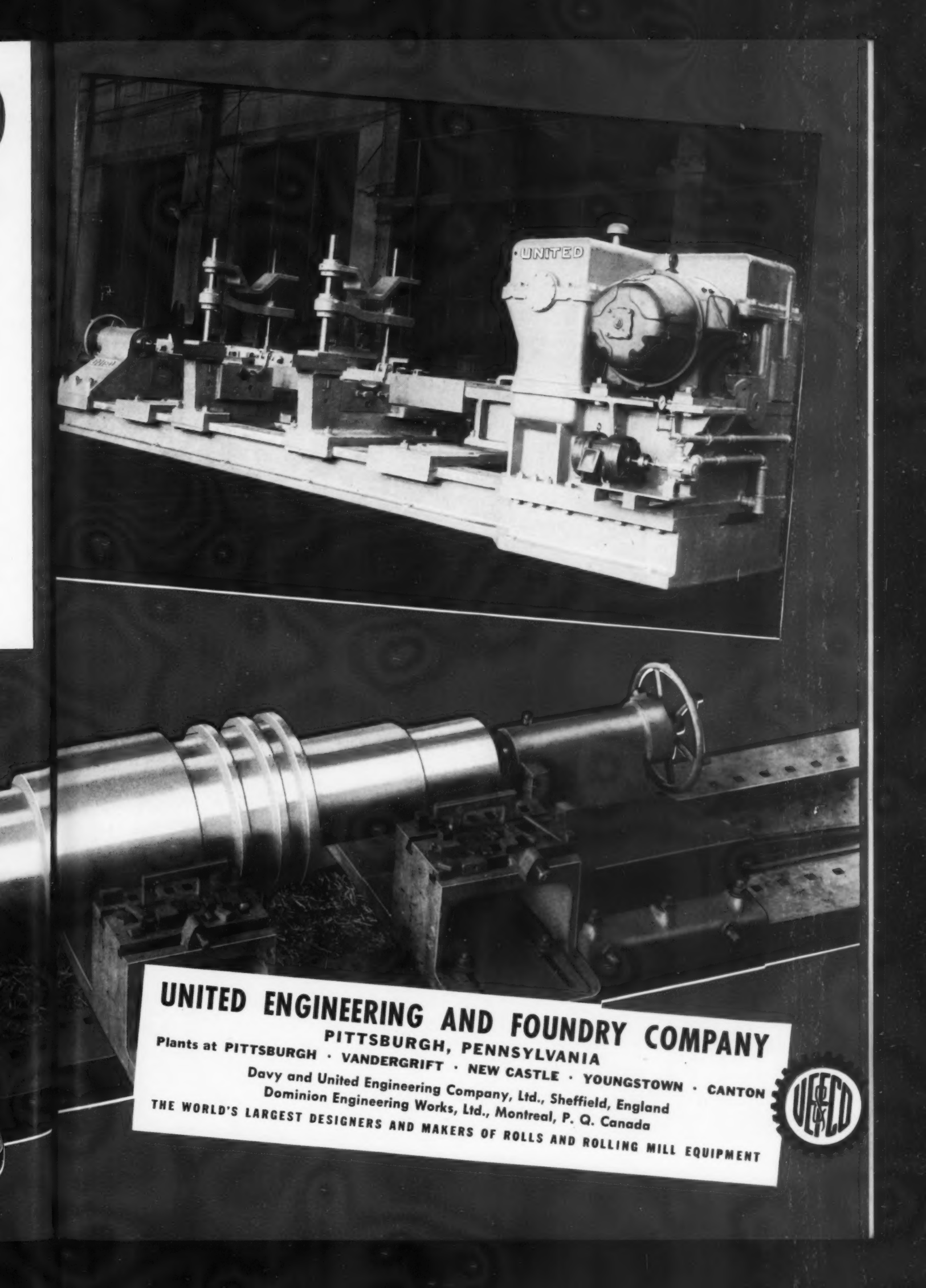
All gearing up to the main cone worm faceplate drive is either single or double helical, is fully roller bearing mounted and carefully proportioned with reference to both velocity and load requirements. These fully enclosed gears and bearings are lubricated by forced oil circulation.

UNITED HEAVY-DUTY ROLL LATHES can be furnished for either "fixed" or "rotating" center.

Consult UNITED engineers for complete technical data.



Showing Comparative Size Between Conventional and "Cone Worm" Headstock



UNITED ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

Plants at PITTSBURGH · VANDERGRIFT · NEW CASTLE · YOUNGSTOWN · CANTON

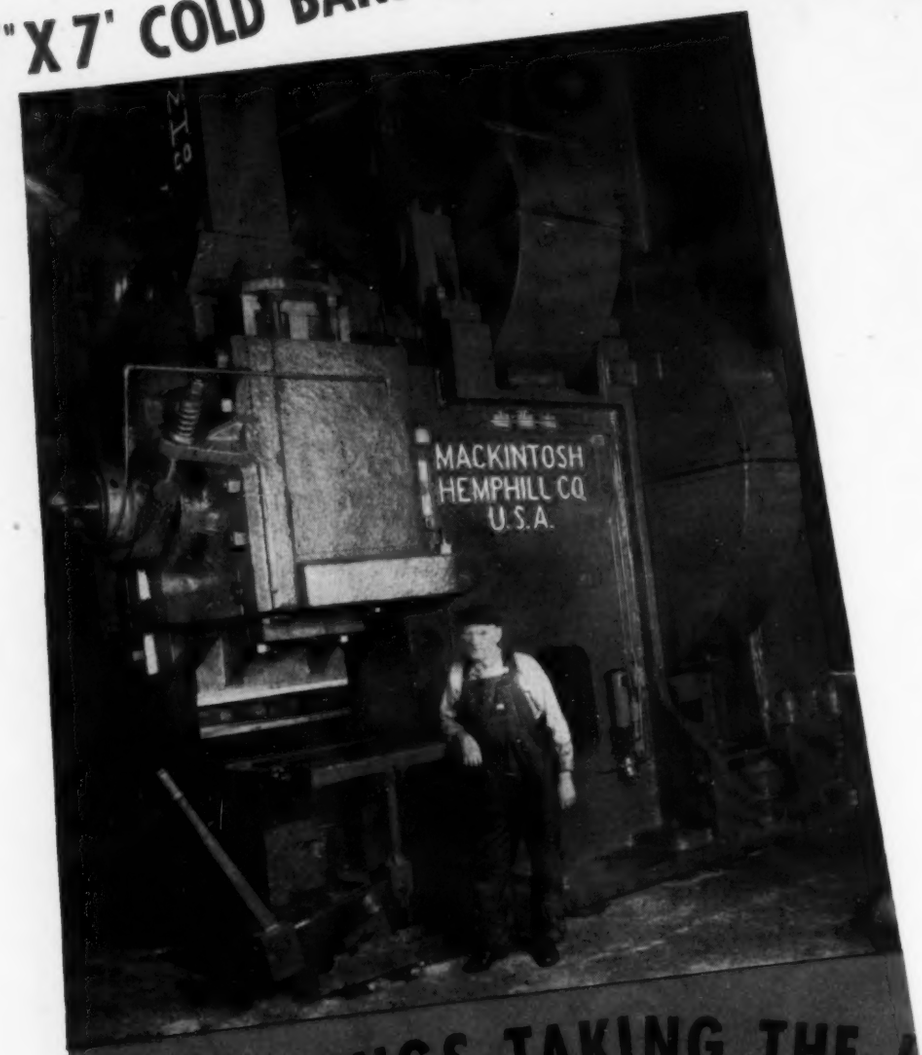
Davy and United Engineering Company, Ltd., Sheffield, England

Dominion Engineering Works, Ltd., Montreal, P. Q. Canada

THE WORLD'S LARGEST DESIGNERS AND MAKERS OF ROLLS AND ROLLING MILL EQUIPMENT

U.E.&F.CO.

SHEARS 7"X7" COLD BARS AS CLEAN AS A WHISTLE



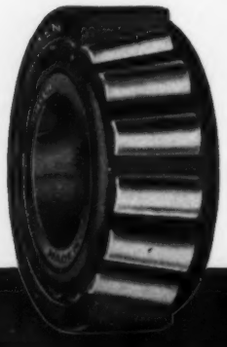
WITH TIMKEN BEARINGS TAKING THE LOAD

This shop photograph shows a 1200 ton heavy duty cold shear designed and built by Mackintosh-Hemphill Company, Pittsburg, Pa. Five of these machines have been produced to date.

The terrific power of these shears is indicated by their capacity. They can bite through one 7" x 7" cold bar or two 5" x 5" cold bars as easily as you could go through a piece of cheese with a sharp knife.

Timken Tapered Roller Bearings are important factors in the performance of the shears, there being 2 double-row Timkens on the motor shaft and 3 in the intermediate shaft. They enable the motor to exert its full power; carry radial, thrust and combined loads surely and safely; hold the shafts in correct and constant alignment; and prevent shaft wear. They make substantial contributions to dependability, long life and low maintenance.

Make sure you have Timken Bearings in any new piece of equipment you buy; then—regardless of its purpose—it will be a better machine. The Timken Roller Bearing Company, Canton 6, Ohio.



TIMKEN
TAPERED ROLLER BEARINGS

THIS ASKANIA FORMULA WORKS!

This time it's Company "B" who found out that "1" is for the first installation . . . (1936) that plus "P" for performance, equals 6 or the total number of open hearth furnaces equipped with Askania Automatic Combustion Control, during the years of 1936, 37, 39 and 40.

In our first example Company A found that this formula equalled 9 . . . in this example Company B found that 1+P=6 . . . you will find that your first application of Askania Automatic Combustion Control will justify you in applying Askania throughout. Facts prove that this formula again and again results in extended campaigns per furnace and increased tonnage at lower cost.

Bulletin 115 tells the whole story . . . Write for your copy today.

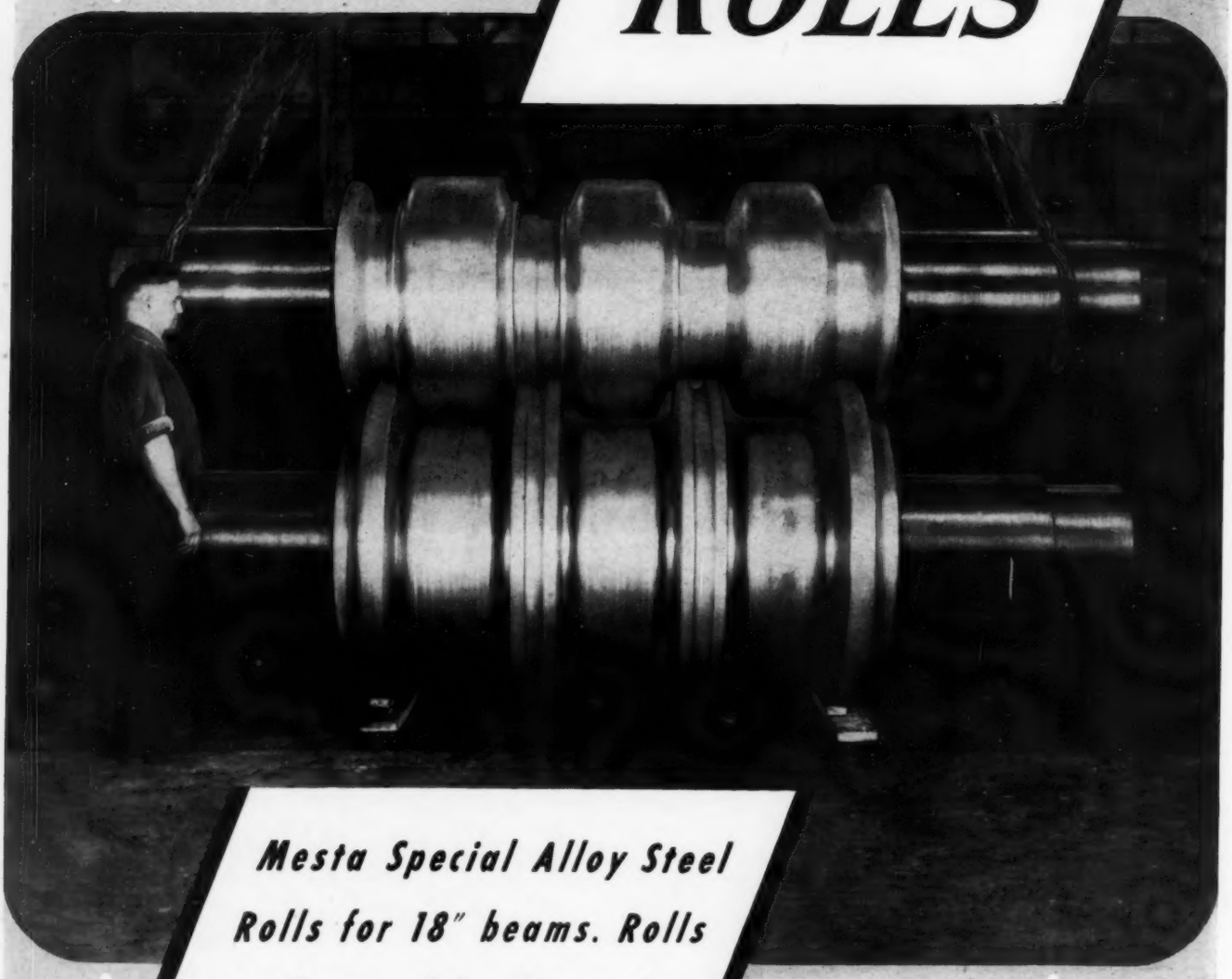
JET PIPE PRINCIPLE

ARMY E NAVY

ASKANIA REGULATOR CO.

1603 S. MICHIGAN AVENUE, CHICAGO

MESTA ROLLS



Mesta Special Alloy Steel Rolls for 18" beams. Rolls are designed by Mesta for any section and furnished with the necessary tools, templates and guides.

* * * *

The Army-Navy "E" Flag with four stars, flies over the Mesta Plant.

Send for your copy of this 64 page booklet containing valuable engineering data. Address your requests to Dept. A-1.

MESTA MACHINE COMPANY · PITTSBURGH, PA.

INDUSTRY'S TASK FORCE

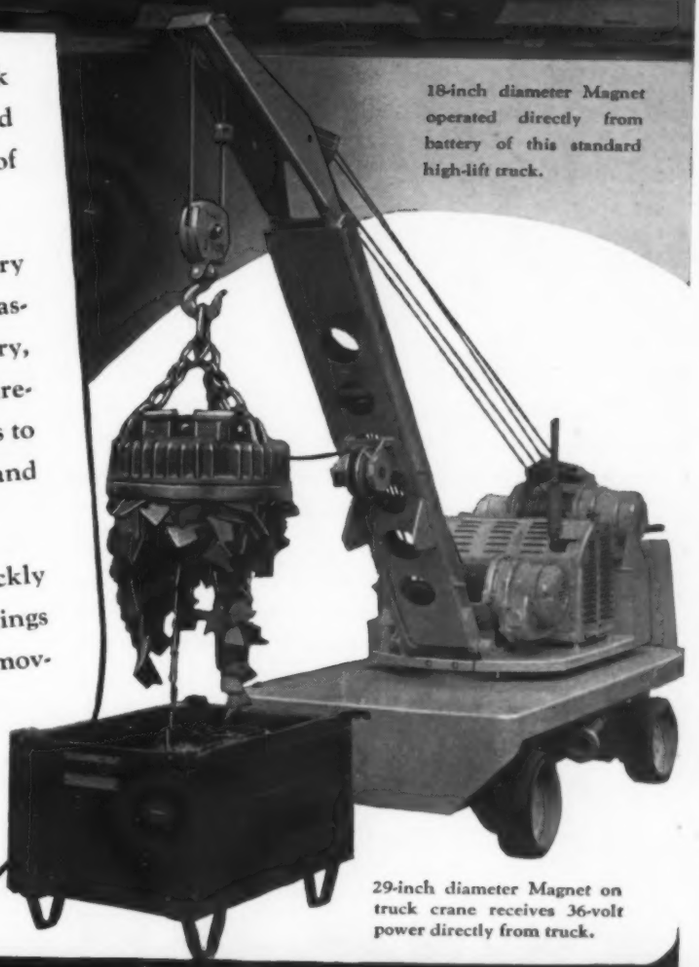
SMALL MAGNETS on Lift Trucks

MANY plants are now using this task force of EC&M small magnets mounted on industrial trucks for a clean sweep of production lanes.

These easily handled mobile units scurry around the plant through narrow passages, into the corners, around machinery, picking up bolts, nuts, turnings, and tire-injuring scrap. They "sweep" hazards to men and equipment from the floors and save valuable materials.

They also handle plant materials quickly and at little cost, such as lifting castings and forgings from floor to machine, moving products in and out of boxcars, and other similar lifting and moving jobs about the plant.

18-inch diameter Magnet operated directly from battery of this standard high-lift truck.



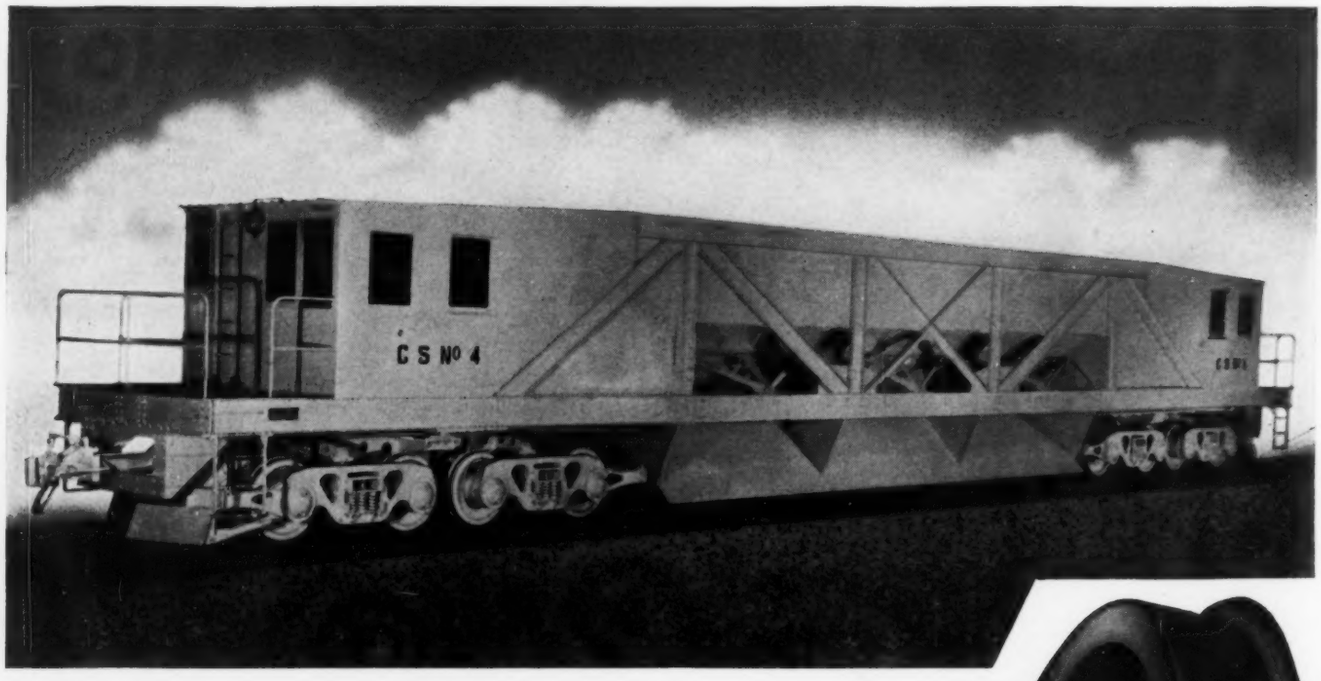
29-inch diameter Magnet on truck crane receives 36-volt power directly from truck.

EC&M Circular Magnets come in ten sizes for all industrial needs. Ask for Bulletin **900**

THE ELECTRIC CONTROLLER & MFG. CO.

2698 EAST 79th STREET CLEVELAND 4, OHIO

Journal BEARINGS
without Journal BOXES



● 120-ton side dump ore transfer car
Built by ATLAS CAR & MANUFACTURING CO.

When you consider the many advantages of SKF Spherical Roller Bearings, you realize why they were selected for this side dump ore transfer car. Journal boxes were eliminated by boring the ends of side frames to receive SKF's. The inherent aligning ability of SKF Spherical Roller Bearings ignores misalignment and deflection and frees high radial and thrust load capacity to accept useful load. There is no increased friction because there is no bearing binding. No adjustments are needed for proper running clearance. All of which totals simplicity of design and low maintenance, year after year.

5580

SKF INDUSTRIES, INC., PHILA. 34, PA.

● *The SKF Spherical Roller Bearing Unit.*

SKF
ROLLER BEARINGS

A new generation of industrial workers is learning about Exide dependability!

New workers are enlisting every day in America's industrial battle. Many of them have been unfamiliar with motive power batteries and the equipment powered by dependable Exides . . . but that picture is changing fast. The long-life of Exide-Ironclad Batteries is convincing these new workers of something experienced operators have always known . . . that Exide-Ironclad Batteries are leading a war of movement on the home front. Remember, only Exide can make an Ironclad.

Write us for a FREE copy of the new bulletin "UNIT LOADS," prepared by The Industrial Truck Statistical Association. Tells how to cut material handling costs up to 50% . . . covers latest developments in material handling . . . includes actual case histories.

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Exide
IRONCLAD
BATTERIES

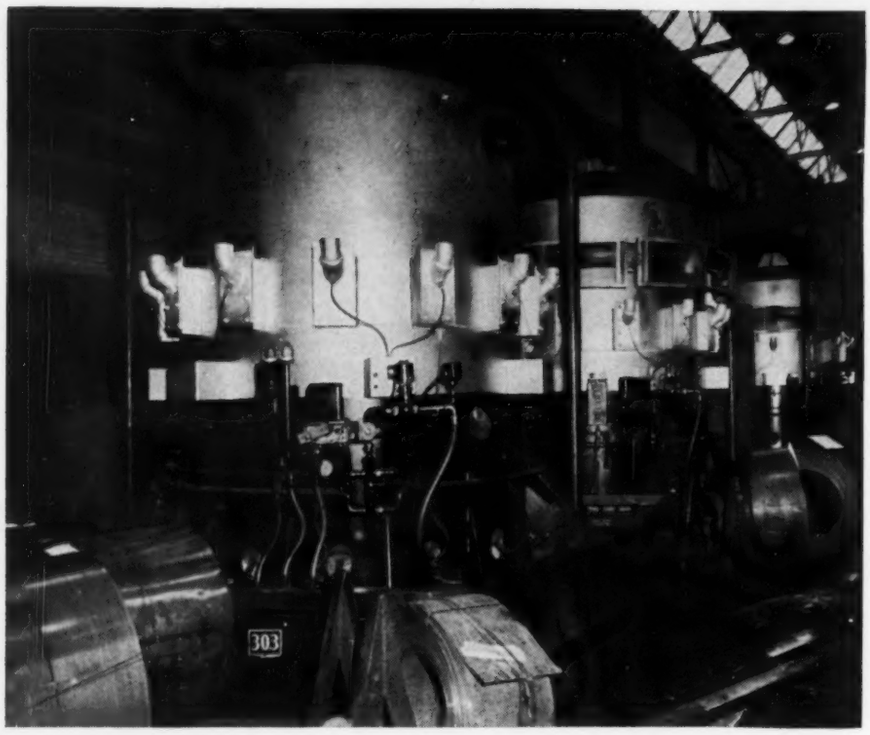
1 High Power, More Production: To get the most from any battery-powered electric vehicle, its battery must deliver good voltage, hold that voltage high, and be ready for emergency demands with a giant surge when needed. Exide-Ironclads do just that.

2 Long-Life, Saves Materials: Rugged Exide-Ironclads are built to last, and save vital materials by getting maximum use from everything that goes into their making. When you buy an Exide you definitely—Buy to Last and Save to Win!

3 Easy Maintenance Saves Labor: Exides are kept charged by the simplest method ever devised. With the Exide Charge Control Unit there's nothing to do but connect the battery to the charging source and turn a knob.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 32

Exide Batteries of Canada, Limited, Toronto



Three of a large battery of Wilson radiant-tube cover furnaces in which temperatures are controlled by the arrangement of Micromax Pyrometers described herein. A Micromax Control Electric-drive Unit may be seen on the front of each cover; some of the Controllers are shown below.

SATISFYING STEEL-FURNACE NEEDS WITH MICROMAX PYROMETERS

Heat-treatment of steel strip, in coils, is the job of the battery of cover-furnaces, shown above, in an Ohio steel mill. These furnaces are capable of extremely heavy production, and among the factors which make this possible is the use of Micromax Control, shown in the lower picture. These are especially designed to give full responsiveness, in handling the coils, with their high heat capacity.

The equipment includes Micromax strip-chart Recording Controllers, and their own type of electric valve-drives. The regulating action proportions the fuel to the load's needs — is floating or throttling, as distinguished from an on-off system. And the regulation is based on two thermo-couples — one located to detect the temperature of the furnace's radiant tubes; the other to detect the surface of the coils of strip. Both couples are permanently connected to the Controller.

While the furnace is coming up to soak temperature, the Controller regulates on the basis of the couple at the tubes. But, when the coils are at temperature, the control shifts automatically to the other couple, against the strip. Thus, while the heating-up is going on, the tremendous heat capacity of the charge can't lead the Controller to send fuel so fast that the relatively low-capacity cover is damaged; and when the shoe is on the other foot, and the charge is soaking, the Controller can consult the charge itself in supplying heat necessary to maintain temperature. At all times, the micro-responsiveness of the Micromax enables it to head off the small changes before they become large, and so hold temperature uniform.

Many hundreds of big-furnace installations and many thousands of men in big steel-mill jobs have made Micromax the *Pyrometer for the really tough, really responsible jobs of automatic temperature control. For Micromax, with the qualities which all pyrometers have to some extent, has those qualities to an advanced degree, by the way in which it is designed and made. And these qualities are applied with full effectiveness in any temperature-controlling situation . . . If you have a temperature-control problem, anywhere in a metal-refining or metal-working plant, outline it to us and an L&N engineer will either make a specific control-pyrometer recommendation, or send you the appropriate general catalog — as you wish.*

Foreman examines Micromax Recording Controllers for the furnaces pictured at top of page

Jrl Ad N-33A-620(2)

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LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.

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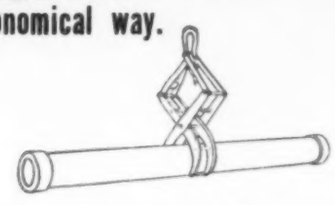
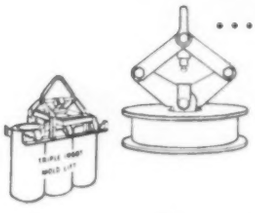
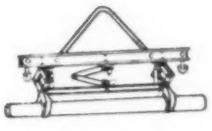
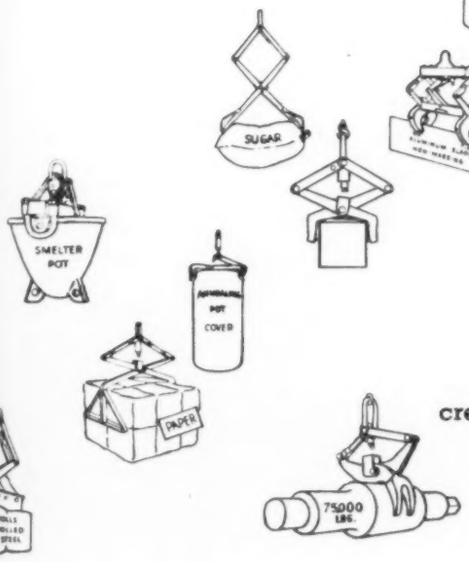


Heppenstall



Safe-T-Tongs





Heppenstall Tongs pick-up, land and release a load by simply raising and lowering the crane—no close work by ground crews needed. Heppenstall Tongs are fully automatic—*not* power driven—they are simple, positive, proved by extensive use. They can be designed to handle any weight, shape or type of material. If you have any repetitive handling job in your plant, it will pay you to write for our Safe-T-Tong Book. Heppenstall Company, Department T P, Pittsburgh, Pennsylvania.

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Heppenstall Automatic Safe-T-Tongs

A TYPICAL CASE *from Airco's Research and Service files*

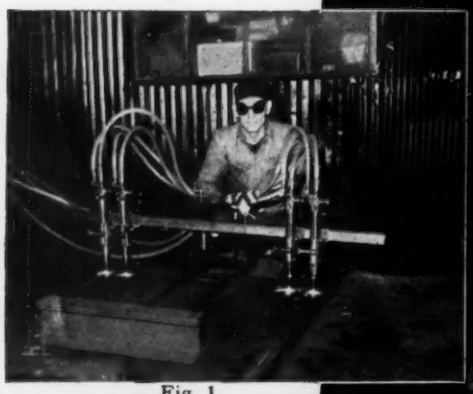

Fig. 1

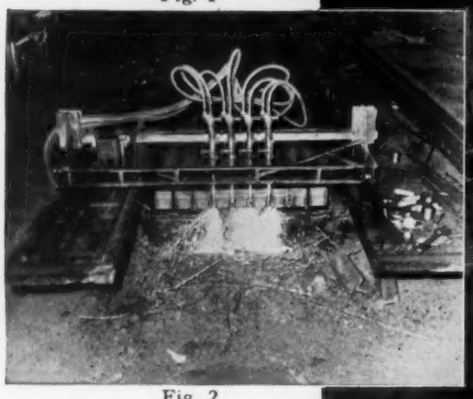

Fig. 2

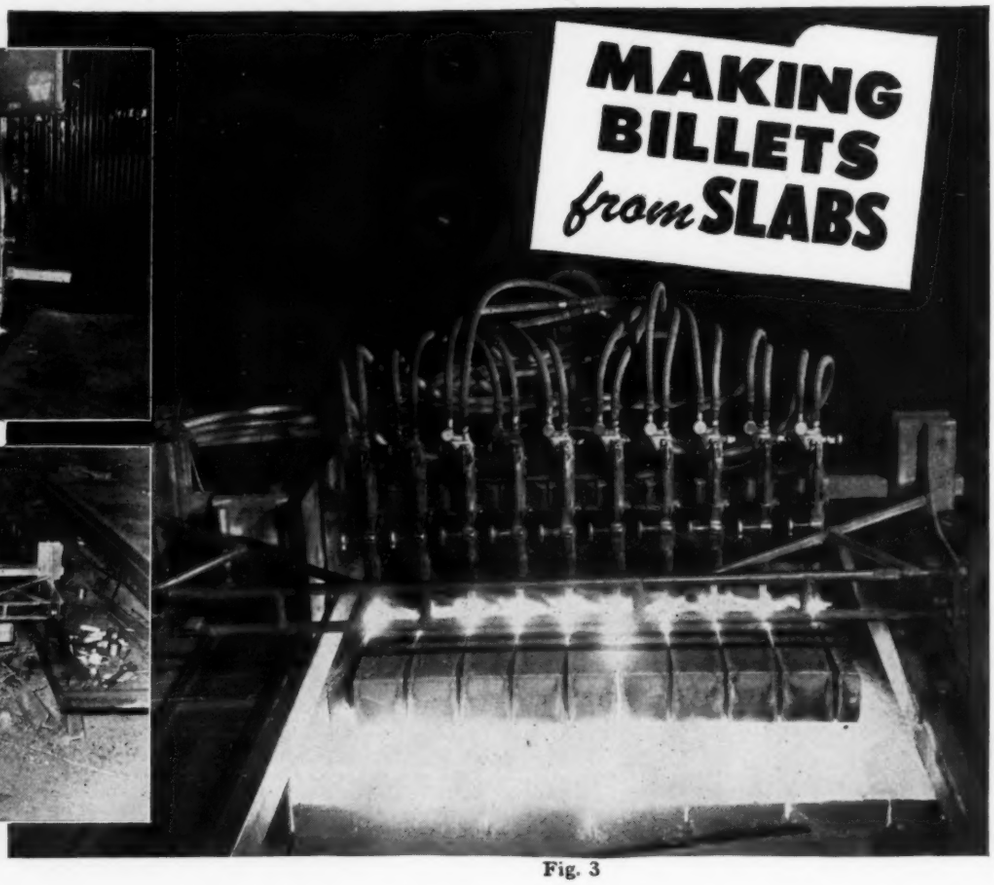

Fig. 3

• A leading flat-rolled producer was called upon to furnish 50 tons of one of his special analyses in billets for rolling into welding wire. There was no billet mill at the plant where the heat was produced so it was decided to flame-cut slabs into billets.

To do the job, four cutting torches were mounted on a five-foot bar which, in turn, was mounted on an Airco Radiagraph (Fig. 1).

Repeat orders made it necessary to develop a more efficient method which would eliminate repositioning of the track and machine set-up to split the center section. Accordingly, a new mounting and carriage, carrying four cutting torches and driven by the Radiagraph was built (Fig. 2). The design permitted repositioning of the torches for making the center cut.

Later, as orders increased, six more cutting torches were added, permitting the complete splitting and trimming of a 37″ x 3¾″ slab, 24 feet long after end cropping, in approximately 32 minutes.

This is one of many examples of practical help rendered to steel producers by Airco engineers. This helpful service is available to all mills on problems involving use of the oxy-acetylene flame and electric arc.

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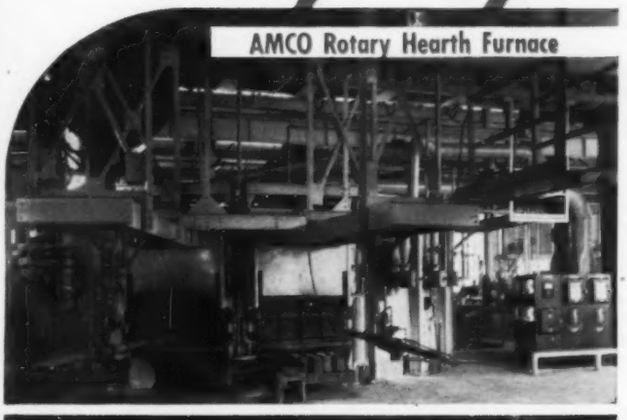
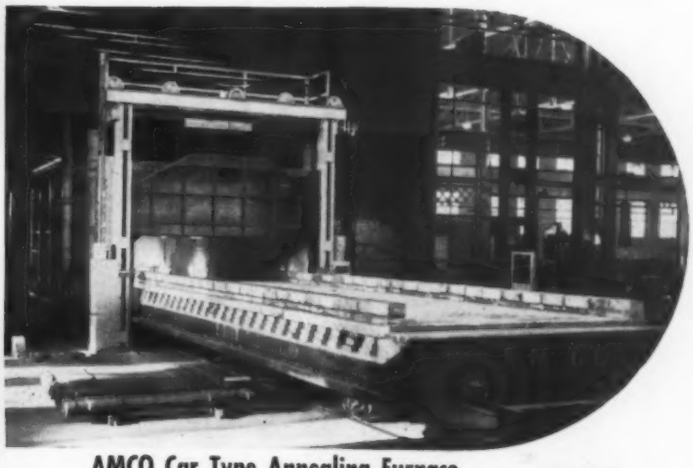

AMCO Rotary Hearth Furnace

AMCO Open Hearth Furnace

AMCO Heavy Duty Forging Furnace


AMCO Car Type Annealing Furnace

The AMSLER - MORTON Company
FULTON BUILDING · PITTSBURGH, PA.

Long gear teeth in sleeve prevent hub from disengaging
Clearance between sleeve and hub permits free end float
Two tapped holes in each hub facilitate assembly and removal
All steel construction
Durable, flexible, oil-resistant packing retains oil inside the coupling and excludes dirt, grit and moisture
Safety flange with countersunk holes for fitted bolts and self-locking nuts
Gasket prevents oil leakage
Accurately generated external and internal gear teeth
Spherical contour of hub teeth permits free sliding and rocking motion
Load cushioned by oil film between the gear teeth assures quiet operation and long life
Machined bands on each hub facilitate accurate alignment
Oil supply replenished through either of two plugged holes
FARREL GEARFLEX COUPLINGS

FOR STEEL MILL APPLICATIONS

The Farrel Gearflex meets every requirement of a flexible coupling. It compensates for angular, offset and combination misalignment of shafts; offers no hindrance to axial float; is simple to install, easy to align, and can be disconnected with ordinary tools without endwise movement of either shaft. There are no elements to wear or break under normal usage. Sealed to retain oil, it is dust-proof and moisture-proof.

A small quantity of a few sizes now carried in stock—rough bored—await your order, subject to prior sale. Write for quotations. For complete description, send for a copy of Catalog No. 443.

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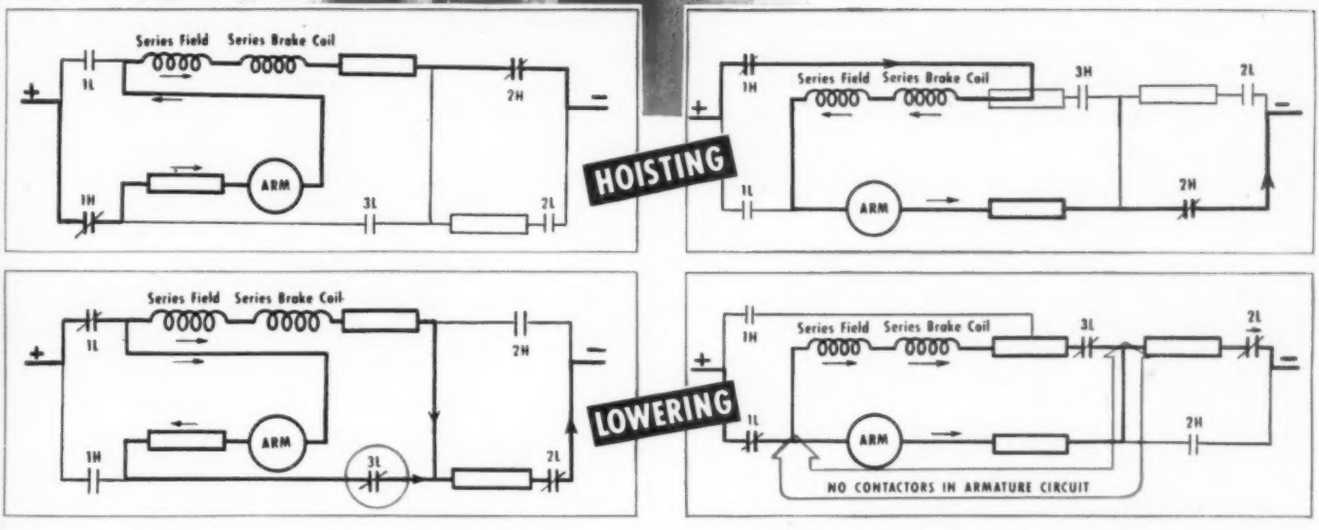
FARREL GEARFLEX COUPLINGS Sizes, Ratings, Bores

Size No.	Capacity HP per 100 RPM	Maximum Bore in Inches	Rough Stock Bore—Inches	
			One Half	Other Half
2	23	2	1	1
2 1/2	45	2 5/8	1 1/4	1 1/4
3	80	3 3/16	1 1/2	1 1/2
3 1/2	120	3 11/16	2	2
4	180	4 1/4	2 1/2	2 1/2
4 1/2	250	4 3/4	3	3
5	350	5 1/4	4	3
6	500	6 3/8	5	3 1/2
7	800	7 1/2	6	4
8	1200	8 1/2	7	5
9	1800	9 1/2	8	6
10	2400	10 3/4	9	7
11	3200	11 3/4	10	8
12	4000	12 3/4	11	9
14	6300	15	13	11
16	9100	17	15	13
18	12000	19	17	15
20	19000	21	19	17

FARREL

Farrel-Birmingham

Safe Crane Control begins with the Circuit



CONVENTIONAL CONTROL

Conventional control circuits apply dynamic braking action when lowering, by reversing the armature. This necessitates the use of a contactor in the armature circuit. (See circled contactor "3L" in diagram.) Should this contactor fail to close the circuit for any reason, there would be no dynamic braking. The Magnetic brake is held released by a separate field circuit and there is nothing to keep the load from dropping.

WESTINGHOUSE PATENTED SAFETY CIRCUIT

Westinghouse Crane Control eliminates this possibility of failure because it reverses the *field*, doing away with the use of any contactors in the armature circuit. (See diagrams.) Since there is no contactor to open the armature circuit you always have braking control whenever the Magnetic brake is released. Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., Dept. 7-N. J-21304

Westinghouse

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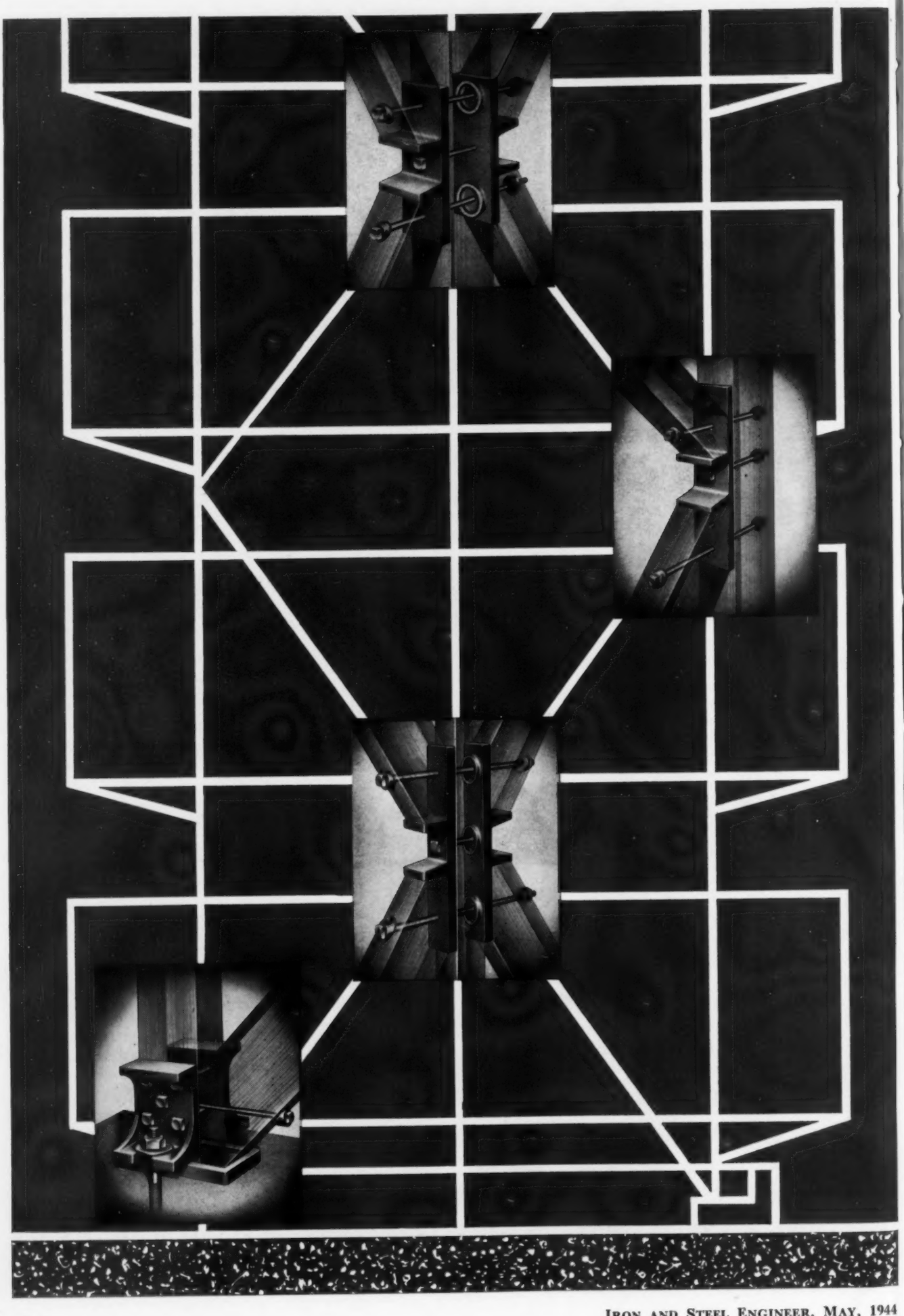
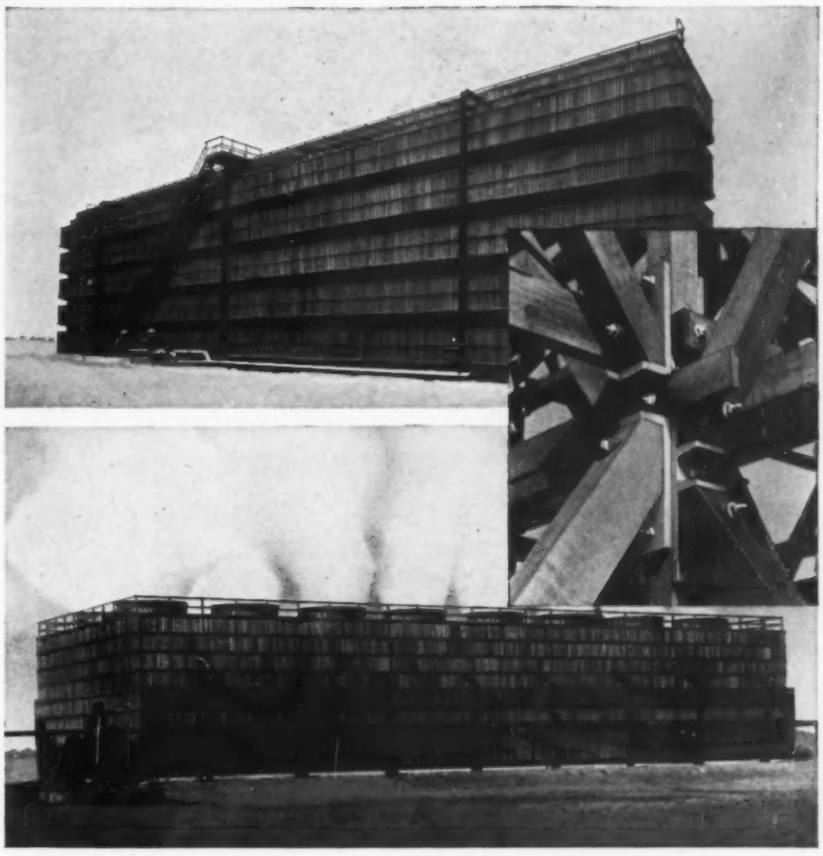


Takes Blows FROM ANY DIRECTION



Longer life, greater structural strength to absorb shocks caused by high winds or earth movements have always been the aim in cooling tower construction. Common reasons for failure have not been due to weakness of structural members; they have been caused by stresses concentrated at the joints in excess of the strength of the joints themselves.

Conditions of temperature, wind, wetting and drying, and the corrosive action of the water have long been recognized as the major factors which cause rapid deterioration of the structure at the joints.

To meet these highly specialized requirements, the FLUOR Shear-Plate Construction (with integral connector rings) has been perfected. The most important advantage of this method of construction is that it fully utilizes the total strength of each structural member. As a result, FLUOR Cooling Towers with Shear-Plate construction set the highest standard for longer life.

Built of durable cast iron of heavy section for greater strength, the FLUOR Shear-Plate is designed to properly distribute the stresses to the various members. They are designed to last the life of the tower.

FLUOR Shear-Plate Construction is now standard on all FLUOR Aerator and Counter Flow Induced Draft Cooling Towers.

All designs for FLUOR Aerator Cooling Towers and FLUOR Counter Flow Induced Draft Cooling Towers are fully protected by U.S. Patents and Patents Pending.

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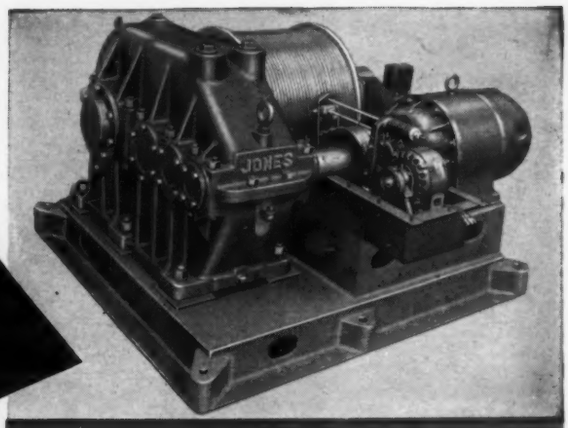
When the drive is built into the unit



● Jones Skip Hoist Drive built as a complete unit by the Jones organization in several types with base to take any motor specified by the purchaser. This drive is equipped with all the modern protective devices such as cam or nut type limit switches, solenoid or disc type brakes and slack cable switches. The drives are single, double or triple reduction Jones Herringbone Speed Reducers.

FOR many years the Jones organization has been developing various types of drive units in which Jones special or standard speed reducers form an important integral part of the unit.

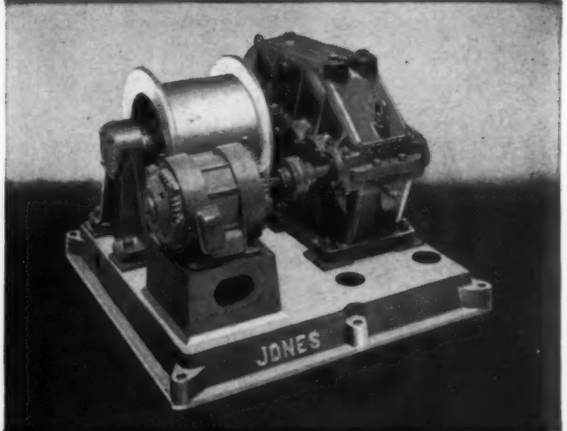
The car puller, door hoist and skip hoist drives illustrated and described here are typical specimens of Jones Unit Drives. These machines are built as complete units by the Jones organization with base to take any motor specified by the purchaser.

The Jones organization has also worked with a great many manufacturers in the application of Jones gears and speed reducers to an extremely wide variety of complete assemblies. You are invited to make full use of this experience in connection with any power transmission problems that you may have.

● Jones door hoists are built in many ratings and may be installed with almost any convenient arrangement of sheaves and cables. Base will take any standard motor. No limit switches of any kind are required with this unit.

W. A. JONES FOUNDRY & MACHINE CO.
4431 W. Roosevelt Road
Chicago, Illinois

Bulletin No. 80, "Jones Drives for Industry", may be helpful in giving you a complete picture of the Jones products, engineering services and manufacturing facilities that are available for helping you solve your drive problems.



● A complete Jones car puller unit. These outfits are for use with wire rope and are manufactured in a wide range of capacities to suit the number of cars to be handled in each plant.

Jones

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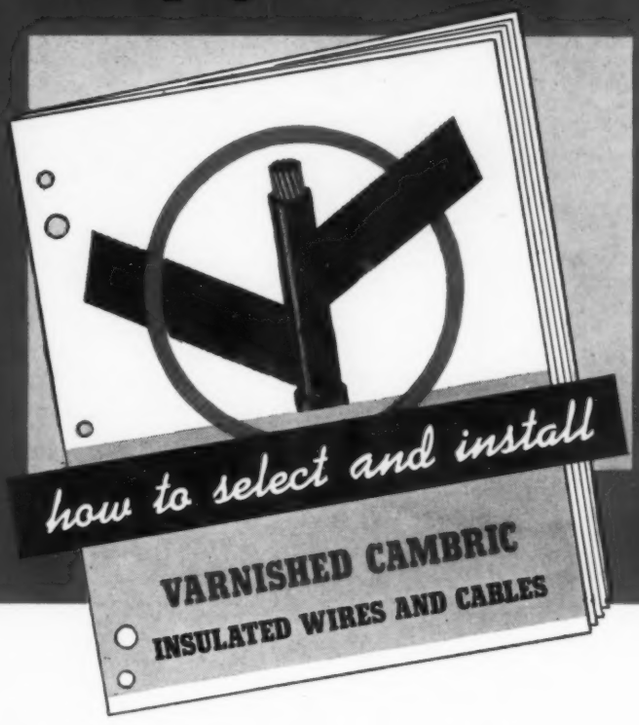

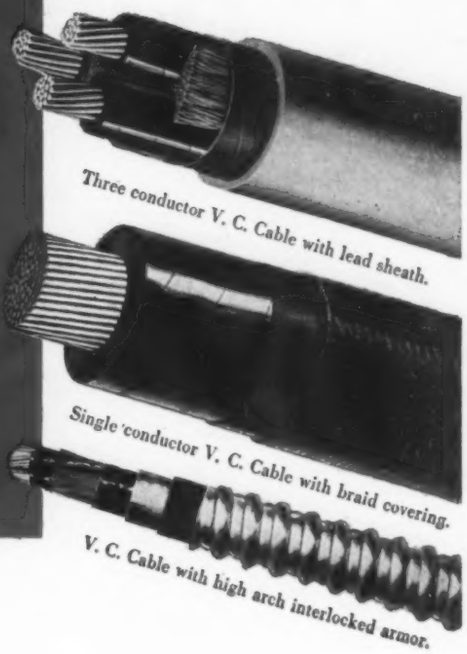

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Write The Okonite Company, Passaic, New Jersey, for Bulletin OK-1013.

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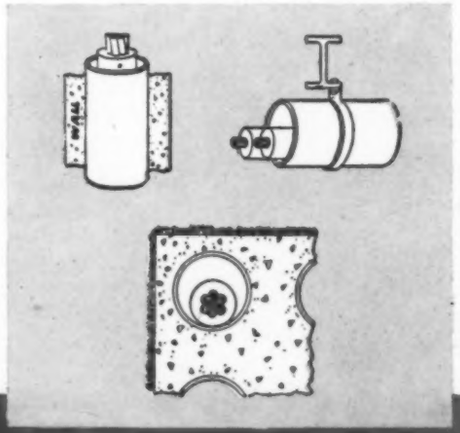

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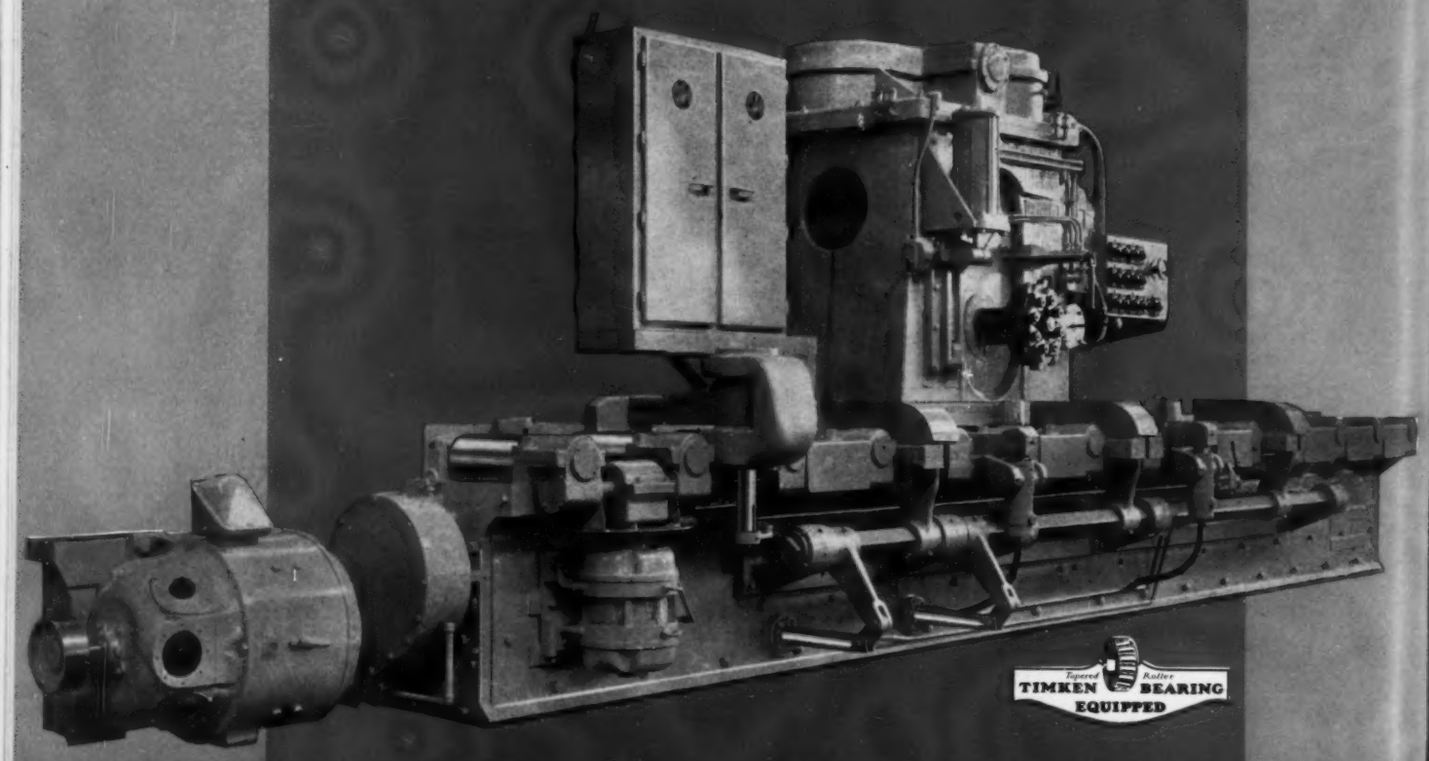

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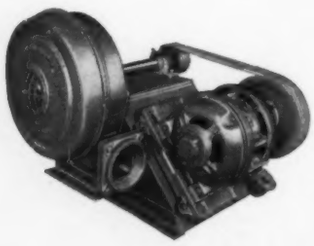
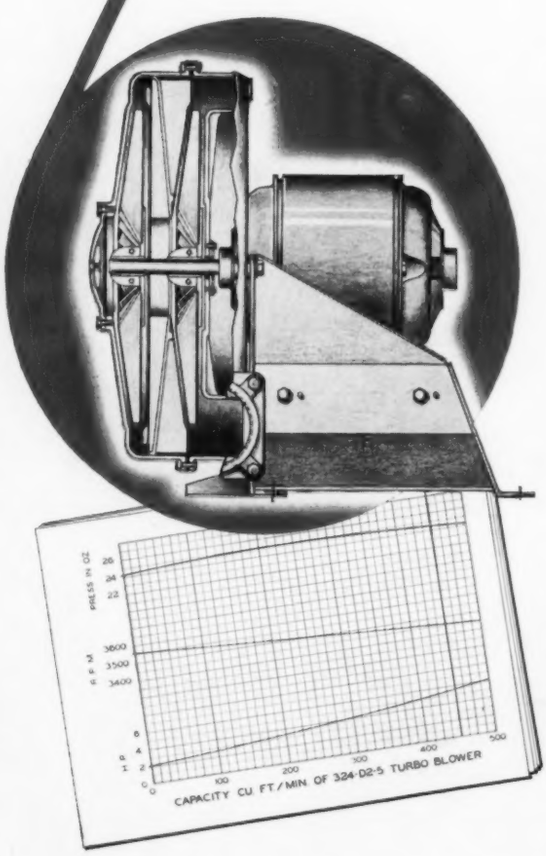
(ABOVE) DIRECTLY CONNECTED. Butterfly valve on intake is standard equipment on larger sizes only. Smaller sizes equipped with intake guard—see section at right.

(BELOW) V-BELT DRIVEN. Used where 60 cycle A. C. current is not available.





(ABOVE) DIRECTLY COUPLED facilitates motor change. Blowers available in single or multiple stage—pressures from 8 to 32 oz. and volumes from 60 to 4300 cfm.

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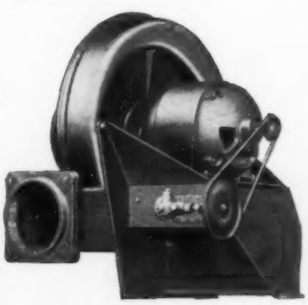

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On the basis of cost per ton of steel rolled, Pittsburgh Rolls are way out in front. The reason for their superior performance is sound enough —they carry the mark of a concern whose one and only product is rolls for rolling mills!

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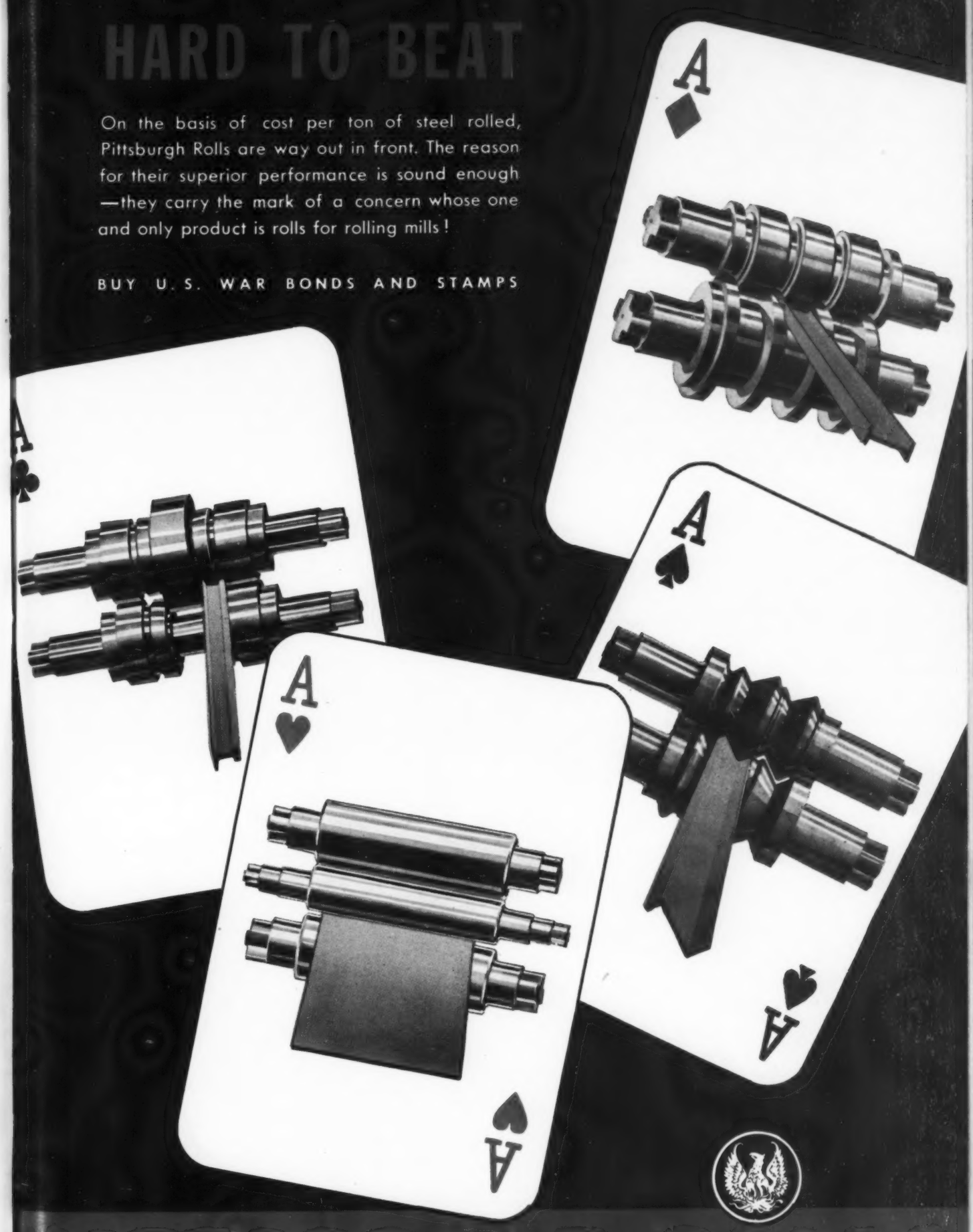
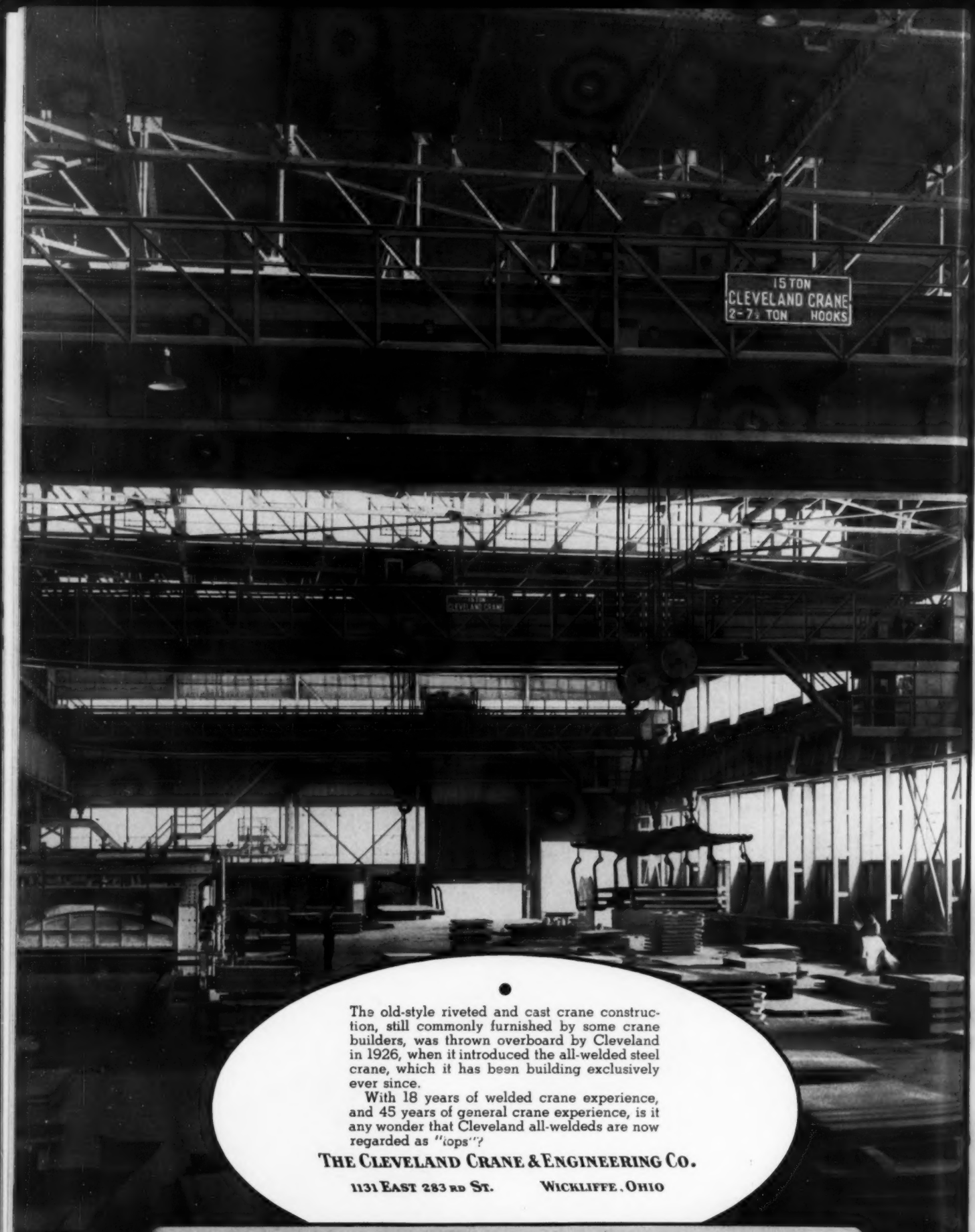


PITTSBURGH ROLLS

PITTSBURGH ROLLS DIVISION of BLAW-KNOX CO.—"Steel's Partner" • PITTSBURGH, PA.



The old-style riveted and cast crane construction, still commonly furnished by some crane builders, was thrown overboard by Cleveland in 1926, when it introduced the all-welded steel crane, which it has been building exclusively ever since.

With 18 years of welded crane experience, and 45 years of general crane experience, is it any wonder that Cleveland all-weldeds are now regarded as "tops"?

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▲

WOULD people really be happy if they were all equals? Or would they languish because there would be no one over whom they might lord it?

▲

STOCKS of bituminous coal in consumer storage throughout the nation continue to dwindle and are now at the lowest point since the start of the war. This, coupled with the outlook for decreased production and increased consumption, practically eliminates any safety margin. Coke plants and steel plants, however, are just about holding their own, with a 24 day supply on hand, although this margin is one of the lowest maintained by any industry. Such marginal supplies range from a 60 day supply for electric power utilities down to 24 days in steel and railroads.

▲

A RAPID glance at financial reports for the first quarter shows steel company earnings to be lower than for the same period last year. Some few companies experienced a slight increase, but the overall figure is about 7 per cent lower — and incidentally, 30 per cent below 1942 and 54 per cent below 1941.

▲

INTERESTING, too, is the fact that tax provisions in the industry are about one-third lower than in 1942, the result of rising labor costs and fixed selling prices, in turn meaning less income for Uncle Sam.

STEEL Company of Canada has announced plans for a continuous hot strip mill. This unit will consist of a finishing train only, using an existing 110 in. four-high reversing plate mill as a rougher. The existing mill, as described in Iron and Steel Engineer for April, 1942, was laid out with the possibility of adding a strip finishing train in mind.

▲

IT has been stated that Russia does business on the basis of what she can pay for, not what she needs. Might not be bad if the idea were generally adopted in domestic economy, both public and private.

▲

IN spite of our expanded steel capacity, the present outlook is for an even tighter situation than ever before, arising in part from heavier demands for shell steel. Plate demands are expected to continue high, with sheet and tinplate increasing. Hence, hopes for larger releases of steel for civilian uses go the way of much wishful thinking.

On the other hand, the production of virgin aluminum metal is being curtailed, being in excess of the facilities for rolling, casting, forging, etc.

▲

THE lake ore season officially opened April 10, more than two weeks ahead of last year, auguring well for the fulfillment of the season's quota.

▲

REALISM is only idealism projected into actuality, according to Colonel Willard T. Chevalier. The realist works to make his ideals come true, while the idealist merely dreams.

▲

JUST in case some of our readers are planning on going to China, they might be interested in learning the Chinese terms for a few commonplace steel plant items. As far as we can see, a slight slip of the pen and you might end up with a safety lock instead of low carbon steel — but we never were any good at languages. The accompanying samples are from an English-Chinese Automotive Nomenclature prepared by C. C. Chang and published by Marmon-Herrington Company, Inc., Indianapolis, Indiana.

Bearing 軸承, 軸承盤, 軸合

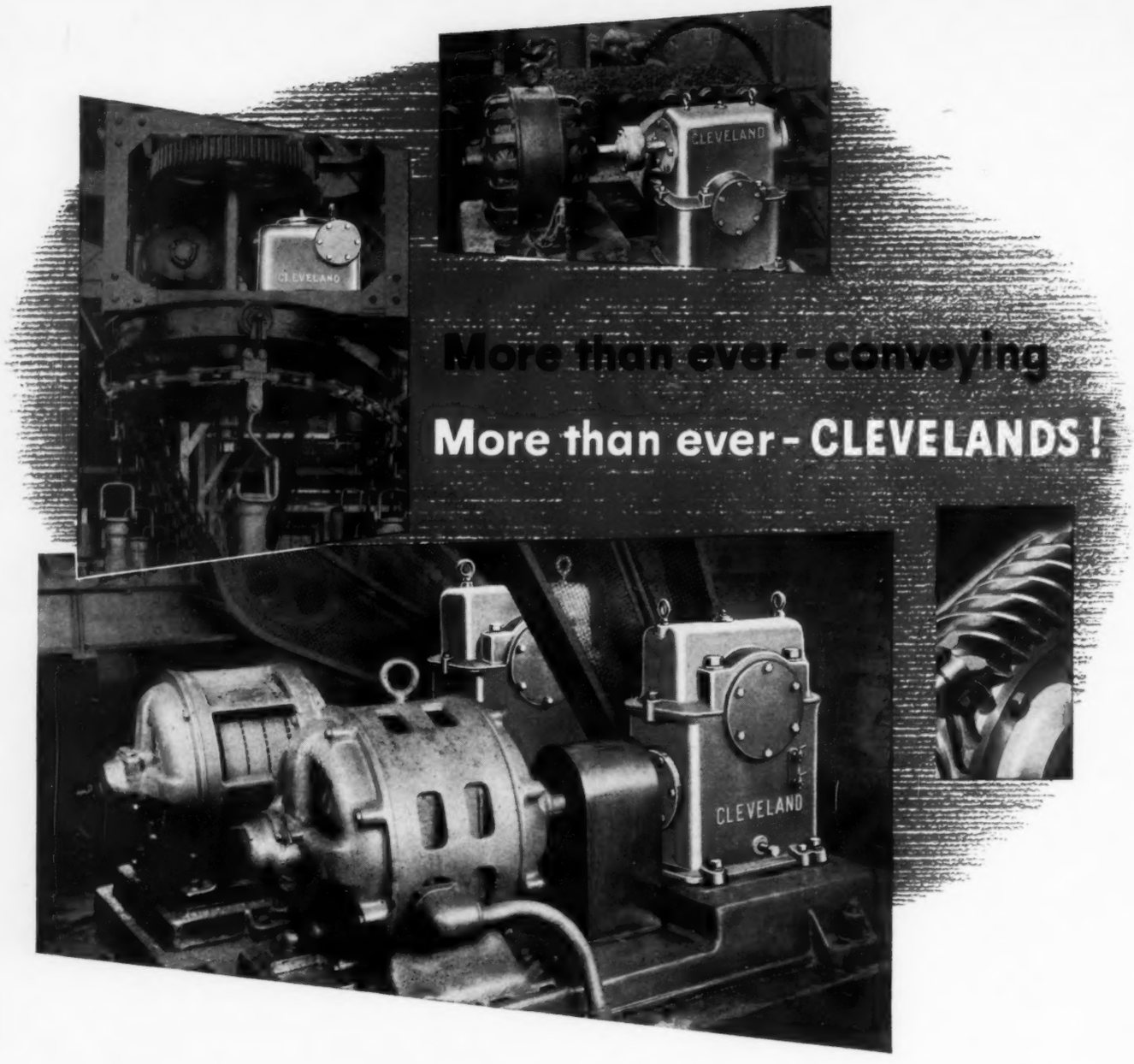
Mill 銑刀, 工廠, 銑

Motor 發動機, 馬達, 電動機

Roll 滾軸, 輾機, 捲

Transformer 變壓器

Travelling crane 行動起重機



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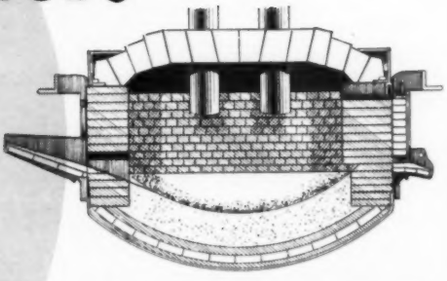

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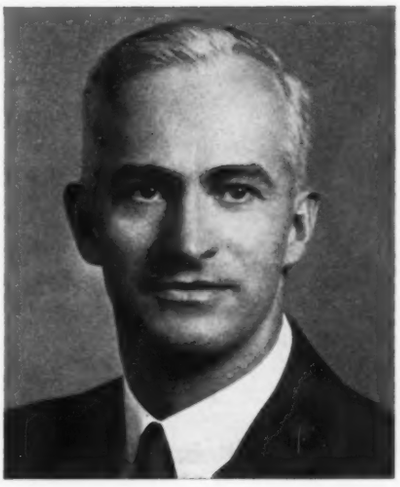

by L. V. Black
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▲ AS the title of this paper implies, this analysis is made from a study of prints, pamphlets, and literature published by manufacturers, and is not intended as an engineering thesis or an undisputable text. Likewise it is not to be conceived in any way as an advertisement or sales talk.

The real object is to explain, in not too much detail, the features of the various controls, hoping in this way to secure additional helpful comments from representatives of the control manufacturers.

Needs for increased production required that steel producing equipment be examined from every angle to determine what could be done to meet the demands.

Prior to this increased demand for steel, the urgent need was realized for a control which would more closely follow the extremely wide power fluctuations in arc furnace operations; which would raise the electrodes rapidly in case the metal scrap fell against the electrodes during melt-down, or if the electrodes touched the bath during the refining period; which would not overshoot during electrode raising or lowering; and which would maintain a steady arc within the range of operating voltage and current taps.

Consequently three manufacturers developed a control which produces much better operating and maintenance practices than obtained previously on some of the older types of furnace regulators. The trade names for these controls are: Regulex by Allis-Chalmers Manufacturing Company, Amplidyne by General Electric Company, and Rototrol by Westinghouse Electric and Manufacturing Company.

Hereinafter, since the writer is not a representative of any of the control manufacturers, no mention of trade names or companies will be made. Neither will the controls be discussed in the order they have been named. This paper deals only with types of equipment, and its assembly in the form of a control.

Basically these controls are alike, that is, all use values of arc voltage and electrode current as their starting point. These component values control the output of generators which are connected to the electrode motors. Any variation in the arc voltage or electrode current will cause a variation in the generator output and a corresponding movement of the corresponding electrode motor. Each electrode has its own independent complement of electrode operating mechanism and control necessary for arc furnace operations.

The individual electrode motors are connected permanently to separate generators, eliminating all control contactors. In this manner free and independent movement of each electrode is obtained regardless of operat-

Presented before A. I. S. E. Philadelphia District Section Meeting, November 5, 1943.

ing conditions attendant with the remaining electrodes.

Manual or automatic operation for all types of furnace regulator control is at the command of the operator.

The complete control consists of (1) an operators' panel with necessary instruments, protective relays, current adjusting rheostats, and control switches; (2) a control panel for the motor generator sets, rectifiers, resistors, relays, etc.; (3) the motor generator sets furnishing power to the electrode motors.

The operator selects the proper voltage, closes the main power supply breaker, and, after the arc is established, turns the current adjusting rheostat to the value of current wanted. After this, any change in arc voltage or electrode current will cause a variation in the generator output and immediately cause the electrode to raise or lower to compensate for the change.

Before analyzing the new control, let us review the constant voltage type most familiar to us over the past years. As previously stated they are all basically alike, so the writer will confine his remarks to the one most familiar to him. The complete electrode regulating equipment comprises an operators' panel, a control panel, and the motors for raising or lowering the electrodes. The operators' panel includes control switches, protective relays, current adjusting rheostats, and meters. The control panel consists of relays of the balanced beam type, forward, reverse and dynamic braking contactors, and various resistances.

Furnace operation with which most of us are familiar is as follows: After charging, the operator selects the operating voltage desired, closes the main power supply breaker, and brings the electrodes down to the charge by hand. After the first few violent contacts are made the control is changed from hand to automatic.

The balanced beam relay mentioned above consists of two operating coils, one series coil energized from the secondary of a current transformer in the electrode lead circuit, and a voltage coil connected from electrode to ground, measuring arc voltage. Under normal operation both coils are energized and variations in current or voltage will cause the balanced beam to close a circuit to either a raise or lower contactor connected to the electrode motor.

The electrode motor is a shunt or compound wound type receiving its power supply from the shop line.

Electrode current adjustment is regulated by a current adjusting rheostat in parallel with the current coil of the balanced beam relay.

The operation sounds simple, and so it is; nevertheless, continual maintenance is required. Inspection, recalibration or adjustment of relays and contactors, and renewal of contacts and other wearing parts are needed frequently. Unless relays and all circuits are kept in good condition at all times, regulation and production suffer.

Momentary contact by the relay and motor contactors is characteristic of this type of control, resulting in a multitude of inching operations by the electrode motor. After each start the motor is brought to rest by dynamic braking. It therefore follows that the electrodes move up or down by a series of short incremental steps. Although in the past this operation caused no dissatisfaction, there is definitely a small loss of time between the time the impulse is orginated by the current or voltage change and the time the electrode is moved.

The new type of control to be explained later is a closed electrical circuit and produces immediate response of the electrode motors. Furthermore, electrode movement is continuous until the initial unbalance is rectified.

Analyzing the new type, or variable voltage controls, we find that one consists of the following equipment for each phase: A rectifier connected to the electrode circuit, to supply the current component to a generator field; and a second rectifier connected between the electrode and the shell of the furnace, measuring the arc voltage, and supplying the voltage component to the same generator field. A current adjusting rheostat is used to secure the proper balance for the desired load conditions. The component exerting the predominant field force will govern the direction and speed of the electrode motor. When the current and voltage components are in balance, the voltage output of the generator will be zero, and the electrode motor will remain at a standstill.

The generator comprises main fields connected to the balanced current and voltage circuits; stabilizing fields in series with the armature; anti-hunt field connected across the generator output terminals and in opposition to the main field; and an auxiliary field excited from an external d-c power source for manual operation of the electrode motors at times when the power supply to the arc furnace fails or is disconnected.

The control comprises necessary relays and resistances to produce slow lowering of the electrodes until the arc has been struck. It also contains necessary control to automatically effect rapid raising of the electrodes and a safe operating lowering speed at all times.

The electrode motors are the conventional d-c shunt wound motors with a commutating field, and each is connected permanently to the output terminals of its own generator. Field excitation is from the shop d-c supply.

The motor generator sets can be furnished either as three two-unit sets, i.e. one set for each electrode motor, or as a four-unit set having one drive motor coupled to three generators.

There are further refinements and details in this control; however, time will not permit too much detail in this paper.

Another control consists of the following equipment in each phase: a rectifier connected to the electrode circuit for exciting the current control field of an exciter, and another rectifier connected from electrode to furnace shell for exciting the voltage control field of the exciter. A rheostat is connected in the voltage circuit to adjust a balance between the current and voltage components for any desired load condition. The current and voltage fields are connected in direct opposition to each other. The exciter has a self exciting field to create stability and prevent overtravel and hunting of the electrodes. The output of the exciter is delivered to the fields of a generator, and the output of the generator is delivered directly to the terminals of the electrode motor. The electrode motor is the shunt type, excited preferably from a rectifier in order to make the installation self contained, or if desired, from the shop d-c supply.

Here again all relays and contactors are eliminated and all connections are permanent. A balanced condition between voltage and current components will result in no generator voltage and the electrode motors remain at a standstill. Any unbalance in current or voltage due to operating conditions will immediately be reflected through the exciter and generator to the electrode motor. The motor speed, either up or down, will depend on the amount of unbalance. The motor will continue to run until the original balance is restored. As the current and voltage return to a normal balance the electrode motor is stopped smoothly by regenerative braking.

The motor generator set consists of one motor coupled to three exciters and three generators, all on one bed plate as a seven-unit set. The motor generator set may be supplied from the furnace bus to make the entire installation self-contained, and not dependent on any other separate power supply; however, in most cases low voltage shop supplies are quite dependable. If connected to the furnace bus additional high voltage equipment must be furnished. One exciter and one generator are electrically connected to furnish power to each electrode motor.

As in the preceeding case time will not be taken for details or refinements.

One other control comprises the following equipment in each phase: a rectifier connected to the electrode circuit for supplying power to the current component field of an exciter, and another rectifier connected between the electrode and furnace shell supplying power to the voltage component field of the exciter. A rheostat is connected in parallel with the secondary side of the current transformer supplying power to the current field rectifier, so as to effect a balance between the current and voltage exciter control fields for the desired load. The exciter fields are connected in direct opposition to each other. A self-energizing field is connected across the exciter armature. A fourth or differential field of the exciter is connected across the generator armature. The two latter fields produce a stabilizing and an anti-hunt effect on the exciter output.

The combined action of these exciter fields under operating conditions will determine the output voltage of the exciter. The output of the exciter supplies the excitation for the generator. The output of the generator is delivered to the armature leads of the electrode motor which is of the shunt type and has its fields excited from the shop d-c power supply.

As in the cases described, the electrode motors will remain at a standstill as long as a balance is maintained between the current and voltage rectifier components, and electrode raising or lowering will take place the instant the current or voltage changes. A large differential between electrode current and arc voltage, as is experienced during a melt-down, will rapidly accelerate the electrode motor. Speed and torque will vary in proportion to the differential, and movements will continue until a balance is again established.

There is an independent motor generator set consisting of a motor, exciter and generator for each phase, so that if some trouble should develop in the equipment or circuits of one phase, it would be possible to finish the heat with the two remaining electrodes.

As before, various details of this control and equipment will not be discussed.

At this point it would be well to compare constant voltage and variable voltage schemes:

Constant Voltage Scheme

(A) *Favorable points.*

1. Very simple.
2. Easily understood by maintenance men.
3. Past experience has proven that on large furnaces exceptionally good regulation has been maintained.
4. Furnace delays have been negligible.

(B) *Unfavorable points.*

1. Continual inspection and adjustments of relays and contactors.
2. Possibility of resistance failures.
3. Greater number of start and stop impulses causing: (a) slight time lag in electrode movements; (b) contactor maintenance; (c) oversize electrode motors.

Variable Voltage Scheme

(A) *Favorable points.*

1. Elimination of contactors and relays.
2. Smooth acceleration and deceleration of electrode motors.
3. Continuous electrode feed instead of inching operation.
4. Elimination of losses in resistors of constant voltage electrode motors.
5. Instantaneous response of electrode motors on changes of current and voltage.
6. More steady arc.
7. Less dipping of electrodes due to overtravel.
8. Quicker raising of electrodes on "cave-ins."
9. Lower electrode consumption and breakage.
10. Greater production.

11. Increased savings in (a) kwhr per ton; (b) cost per ton; (c) electrode costs.

In this connection it might be added that we have been informed by one of the manufacturers that tests will soon be made using both types of regulators on the same furnace under the same conditions, which the manufacturer believes will give a definite answer to some of the above points, namely:

1. Less dipping of the electrodes due to overtravel.
2. Lower electrode consumption and breakage.
3. Greater production.
4. Increased savings in kwhr per ton, cost per ton and electrode cost.

(B) *Unfavorable points.*

1. Maintenance of rotating machines.
2. Small losses involved in motor generator set operation.
3. Any trouble experienced with exciter or generator fields, or rectifiers, may cause erratic operations and may be difficult to find.
4. Because of the characteristics of several of the controls it is necessary to provide special means to safely lower the electrodes at slow speed down to the cold scrap when attempting to strike an arc.
5. Necessary to carry a spare motor generator set to prevent a lengthy production delay in case of a failure of either exciter or generator.

From the above may be seen that all the controls have remarkable features. For the variable voltage controls the most important of these features are:

1. They perform a much better job than the constant voltage types.
2. They can be applied to large or small furnaces.
3. They should give the user no trouble electrically or mechanically.
4. They can be built to meet the customers' available space requirements.
5. They offer a valuable addition and refinement to arc furnace regulation.

In the final analysis the advantages of variable voltage control can only be proved by application and operation. That being true it is recommended that the prospective user keep all control manufacturers informed about his problems, in order that they may be able to offer suggestions in regard to the proper selection of control to meet his particular requirements.

DISCUSSION

PRESENTED BY

C. C. LEVY, Industry Engineering Department, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania

G. E. SHAAD, Industrial Engineering Division, General Electric Company, Schenectady, New York

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H. H. ANGEL, Electrical Department, Bethlehem Steel Company, Sparrows Point, Maryland

H. K. HARDCASTLE, District Manager, The Electric Controller and Manufacturing Company, Philadelphia, Pennsylvania

C. C. Levy: I am interested in Mr. Black's paper because I think he has presented the case for the three manufacturers very fairly, even though I do not agree with all his conclusions.

One point that I would like to call attention to is that in his paper he made the comment that it was necessary for the operator to start the furnace speed and control by manual operation, and that after the first few violent contacts he could throw it over to automatic control.

That, however, is not necessary with a properly designed regulator control of any type. You should be able to close the circuit breaker which of course will give a condition, with electrodes above the arc, of voltage on the electrodes but no current. With that condition, the unbalance occurring will operate the electrodes in the direction to lower, and they should lower until the first one strikes the charge, when the differential should disappear and the balance should prevent it going any further. After the next one strikes, the current will start and the arc will be drawn, so that you can start a furnace in operation by simply throwing over to automatic control.

In relation to the constant voltage type of control as compared with variable voltage type, I think that first we should look at the operation of the furnace itself and analyze it a little more closely before we reach conclusions to the effect that there is a great and remarkable difference between these two methods of control.

In the first place, the furnace operation can be easily divided into two quite distinct periods — the first when the furnace is melting down, and the second when it is refining.

In the refining period it only takes a glance at the graphic meter chart, if you have one, or by simple observation of the motors themselves, to see that the load is extremely steady during this period. The arc is constant pretty nearly all the time, and the regulator, no matter what kind of regulator it is, has very little to do. That being so, it is difficult to see how any different type of regulator, whether rotating or constant voltage type can really influence the time or the kwhr consumption during the refining period. I think you will find it very difficult to prove that claim.

Now, in the melting period, the furnace of course is very active. The swings of current and voltage are violent, and the conditions are quite different from those that exist during refining.

Two things favor the variable voltage type of control

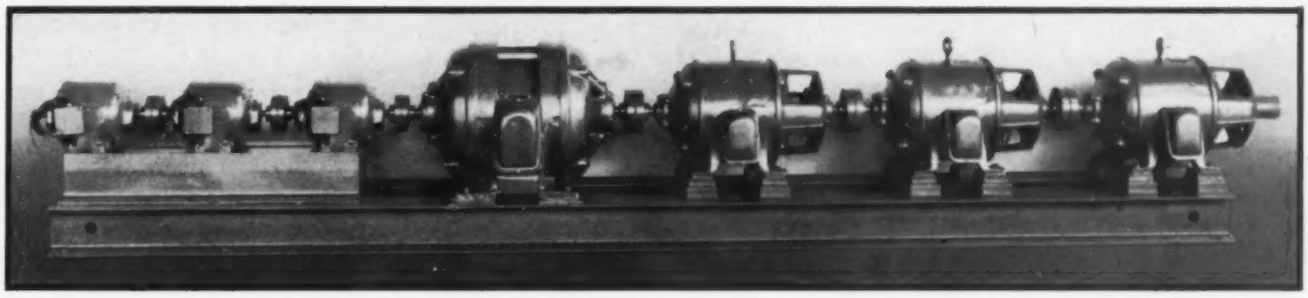


Figure 1 — Motor generator set with driving motor, three generators and three exciters (one for each phase) for arc furnace electrode control.

during the melt-down period. One is that when a short circuit or cave-in occurs on the furnace, you will get a very high voltage applied to the electrode motor and a high acceleration, to pull the electrode away from the short circuit. That is inherent in the variable voltage control. It is also something that has to be restrained because you cannot carry that to the extreme and overload the electrode motor by having an extremely high voltage applied to these armatures.

The other point which is questionable as to its value is that, in approaching the balance point, the torque of the motor in the variable voltage control is gradually decreased, and we depend upon regenerative breaking to bring the motor to rest.

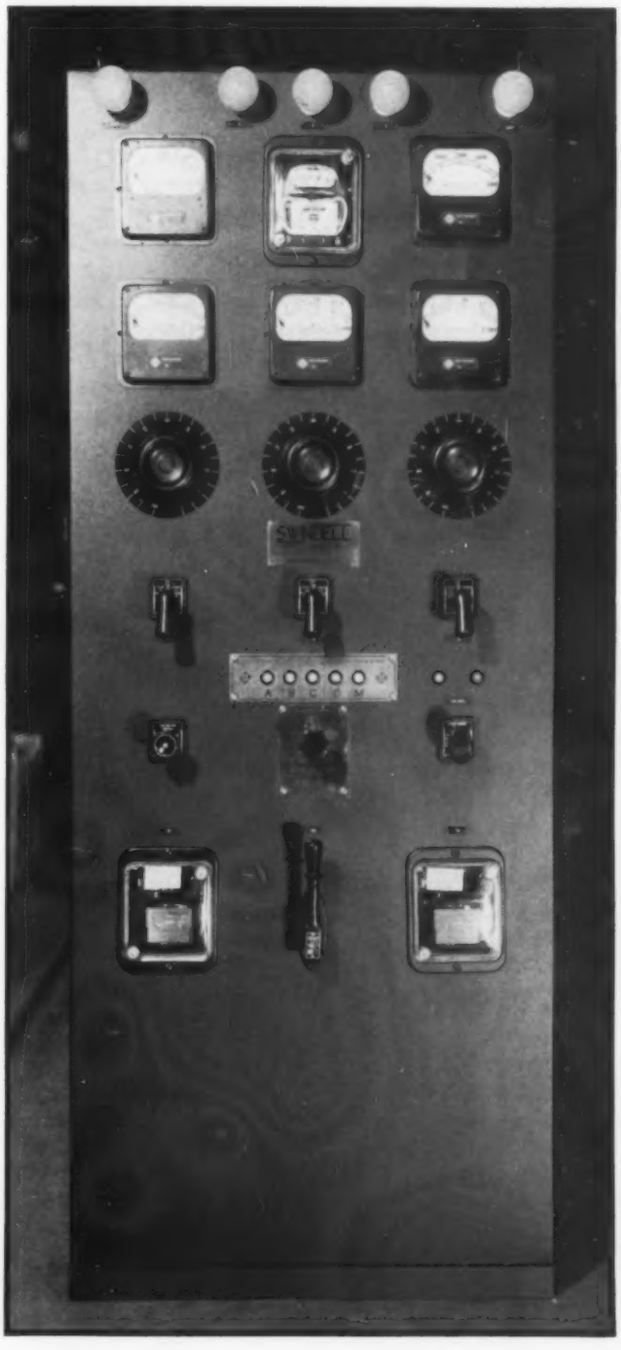
On the other hand, as Mr. Black explained, the constant voltage type of regulator approaches its balance points by incremental steps, that is, it inches its way into position. Those are inherent differences between the two operations, and you will find if you examine the oscillograph of the operation of the two, it is plain that one comes down gradually, by steps, and the other moves right into position, and then moves a little over position. In other words, you get an up-and-down motion of the electrode, which has to be restrained in order to get in position; whereas the other gets into position by jerks.

It is extremely difficult for anyone to evaluate the difference in time between those two conditions. You are going to say one takes longer than the other — that it takes longer to heat, and so on. But I don't see just how that time can be evaluated. But the first condition, in which the regulator pulls away from the charge quite rapidly, has a distinct advantage in that the circuit breaker is likely to open much less frequently than with the constant voltage control, and that, of course, represents some saving in time.

G. E. Shaad: I have been called over-enthusiastic about the possibilities of rotating control, but after being close to the development and seeing many installations in operation, I feel my enthusiasm is amply justified. An installation of duplicate six ton furnaces for example, one with magnetic control and the other with amplidyne control, shows a better than 10 per cent improvement in melt-down time with the amplidyne control. In this particular installation, there is only a slight difference in power consumption, but the amplidyne controlled furnace averages about 1 per cent less kilowatt hours per ton.

It is very difficult to make definite comparisons between the results of magnetic and rotating control, for too much depends upon the condition of the magnetic control. A modern magnetic control — when it is in first-class condition — will do a good job, but is difficult to keep in top condition. By comparison, the amplidyne

Figure 2 — Standard operating panel for one make of furnace.



control, with its smooth, fast response, provides better regulation, and once installed, needs no periodic adjustment.

The amount of improvement will depend upon the furnace and the furnace operation, but to obtain the maximum benefits the control must provide the highest sensitivity that the furnace will allow.

You must remember that the control depends upon the furnace operator for the setting of the current values. In many cases, you will find the furnace operator using current values entirely too high, and that by reducing these current values, the kilowatt input to the furnace will actually be increased. If your furnace is being operated at a power factor of about 80 per cent, you are getting the maximum power into the furnace that can economically be used.

L. W. Long: Mr. Shaad has made several comments with which I agree 100 per cent as to the operation of this type of equipment. The equipment can do only part of this job. The rest of the job remains with the operator and is also dependent upon the type of furnace as supplied by the furnace manufacturer.

Our experience has proven that the type of control that is referred to can be used only with one particular type of furnace. As soon as the control is used with another type of furnace, it will be necessary to make certain adjustments in that control. In one case you may have a hydraulic system — in other cases winch cable. There are different weights to handle, and so on, so that in each case I believe it is the intent of the electrical manufacturer that the whole job should be diagnosed to determine just what type of control should be used.

Some of the results which we have obtained with this type of control do not quite agree with Mr. Shaad's comments. The first control placed in operation has been in service since May, 1942. We have had a chance to watch the operation of these controls. I want to point out here that comparisons that are made can only be made under conditions in which the two furnaces are exactly alike, as to size, weight, size of electrode motors, the type of scrap used, the operator and melter. All of these things enter into the results obtained.

We have had one particular case in which the customer, a foundry operator, has gone about as far as it is possible to do so, to correct all of the improper operations, which may have existed. In other words, all the conditions in this case were exactly alike for the two types of furnaces. The only difference was the type of control. I have here the results, which I have just received, for the month of October for one foundry. These records are taken by weeks, and I believe the results indicated are of great importance.

The melting in minutes per ton — there is a difference here of 10½, 11½, 11 and 11½ per cent in the melting time for each of four weeks in one month between the rotating type of control and the contactor type.

Another item is the number of heats per week. These are all taken for an 11 foot furnace shell, in which the charge is 9 to 10 tons of metal. The difference here between rotating type control and the contacter type is in the order of 12 to 22 per cent. There are some factors which caused this much difference. It is quite possible that one of these furnaces was down for relining at some time.

In the matter of kwhr consumption the rotating type of control shows improvements on the order of 13, 12, 11½ and 10 per cent for each of four different weeks during one month.

All of these figures presented indicate that the rotating type of control results in lower over-all cost to the user.

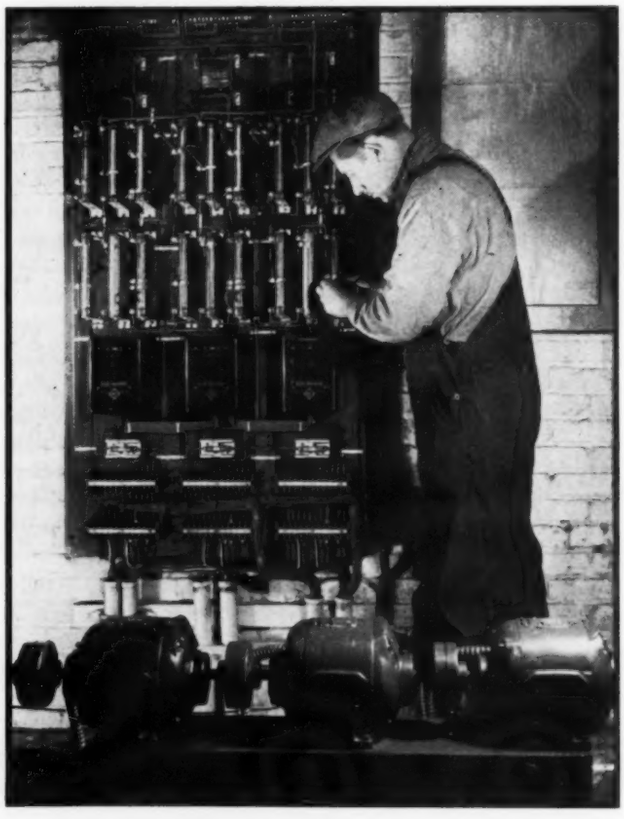
All of the above figures are records after both types of control were adjusted very accurately. I know that both manufacturers involved in this particular problem have spent a great deal of time to see that the controls were functioning properly.

Figure 1 shows the motor generator set with the driving induction motor, with three generators — one for each phase — and one exciter for each generator. To this set we can add another generator for auxiliary power to excite the fields of the winch motor. Other sets of different design are available. We are now gathering data on these two types of motor generator sets. Quite a few of each are in service, and it is expected that equal results will be obtained from these two sets. There are today 32 of these sets in operation. The development work on this control has not been stopped as we think other refinements can be made.

Figure 2 shows the standard operator's panel for a particular furnace manufacturer. It does not vary very much from the panels which you probably have in your own plants.

Figure 3 shows the auxiliary panel on which the relays and resistors are mounted, as mentioned in Mr. Black's paper. As I mentioned before, each set has to

Figure 3 — Auxiliary panel on which relays and resistors for electrode control are mounted.



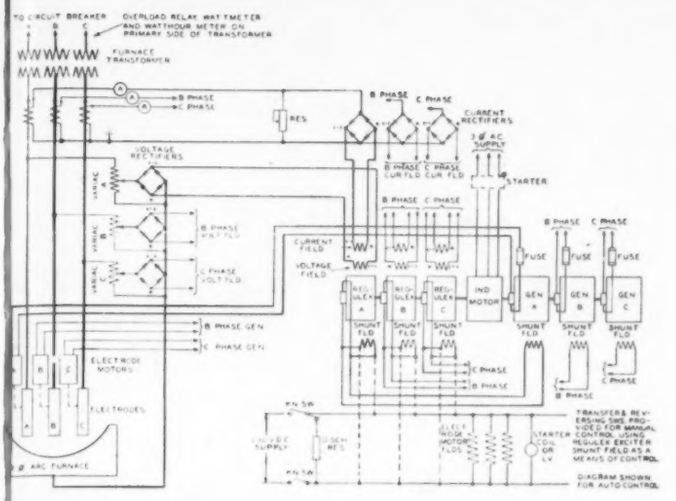


Figure 4 — Schematic diagram of one rotating control system for three-phase arc furnace electrodes.

be properly adjusted as to resistance, and so forth, for each particular job.

Figure 4 shows the electric circuit. It is rather a simple circuit, and the system is a Ward-Leonard system, with which you are no doubt familiar. The circuit consists of a current field in a small exciter, which is energized from the current transformers in the low voltage of the transformer and rectified. The voltage field is energized through a rectifier from the voltage from one electrode to ground. The two fields are normally balanced. In the case of an unbalance between current and voltage, the exciter supplies voltage to the generator, which, in turn, supplies voltage to the winch motor. There is an auxiliary field on this same exciter, which is used for manual control.

L. V. Black: Mr. Levy said he did not agree with some of my conclusions. In my paper I stated that several manufacturers did not agree with a few of the conclusions, and also that there were several companies performing tests, using their constant voltage and variable voltage controls on the same size furnace and under the same operating conditions. Such tests under actual operating performances will answer the questions in doubt.

I should like to ask the representatives of the control manufacturers to enlighten us on one point. At present some trouble is experienced with burn-outs of electrode motors, either from the standpoint of faulty maintenance, overload conditions, or any number of other causes. Can we expect this trouble to be multiplied by the ratio of the additional number of pieces of rotating equipment needed?

G. E. Shaad: Mr. Black has raised a point that is one of the problems with which we must contend. The capacity of the generators supplying the electrode motors is more than ample, providing the electrode motors are not overloaded. If, however, you have a 3 hp electrode motor carrying a 5 hp load, the motors will be continually burning out, and if we supply a control for 3 hp motors under these conditions, then you will have trouble with the generators and control as well as the electrode motors.

H. H. Angel: What type of electrode motor is used — is it the standard shunt motor, compound or series? I would imagine shunt.

L. V. Black: Frankly, I do not know if the same type motor is used for all applications, but I believe the majority of the electrode motors are shunt-wound motors. They are motors with a very small diameter armature, so as to allow quick starting under load and quick stopping.

H. K. Hardcastle: Maybe I missed it in the remarks made by Mr. Long but in speaking of the comparison in efficiency and kwhr per ton, etc., with the constant and the variable voltage motors scheme, I missed which was which.

L. W. Long: The so-called constant voltage type of control is one in which only one voltage is applied to the winch motor. When an unbalance exists requiring movement of the electrodes, the contacters close and 250 volts d-c is applied to the winch motor. In the rotating type of control only sufficient voltage is supplied to the winch motor to move the electrodes the desired amount. The amount of voltage required depends upon the resistance offered by the electrode and its own weight. In a large furnace it might require a minimum of 20 volts to move the electrodes, whereas on the small furnace only a few volts would be required.

I again want to point out that, if the winch motor is of sufficient size, the control supplied will function correctly.

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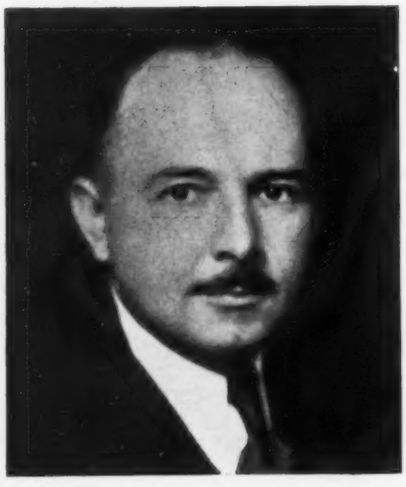
Centralized Lubrication

FOR BLAST FURNACES



. . . . centralized lubrication on blast furnaces preserves equipment, reduces lost time, saves critical materials and provides complete safety for the oiler . . . .

by A. J. Jennings

VICE PRESIDENT

THE FARVAL CORPORATION

CLEVELAND, OHIO

▲ THE blast furnace department has some of the greatest natural hazards in the steel industry and the lubrication of the bearings on the furnace tops is probably one of the most dangerous jobs that must be performed at regular intervals. In order to reach all bearings, many of which are 175 to 200 feet above ground level, men must climb all over the top structure and in the case of some of the sheave bearings, only a monkey or an experienced tight rope walker could reach these points. In addition, the men are directly exposed to the poisonous furnace gases for a large part of the time. In fact, oilers have been severely gassed while lubricating the skip hoist and bell mechanisms.

The stock line recorder sheaves shown in Figure 1 will indicate some of the acrobatics expected of the oiler in his attempt to grease these points. The three sheaves stuck out on a girder, 173 feet above ground level, are typical of about a dozen such sheaves scattered out on hard-to-reach places. The stock piles and ore bridges below give some idea of the height at this point and we might add that with the stiff wind usually encountered up on the furnaces, the average visitor will grasp the rail pretty firmly, even though he is standing on the walk way and not crawling out on the girder, with a grease gun in one hand. Stock line recorder sheaves, test rod sheaves, and hoist sheaves on the skip bridge give a total of 37 of these points to be lubricated.

The small bell beam and the 14 important points of lubrication on its trunnions and links are also located at the 173 ft elevation. Figure 2 shows the lubricant measuring valves mounted on the guard rails at either side, with flexible connections leading to the bearings on this equipment.

There are 33 points of lubrication at the level shown in Figure 3, on the skip hoist bull wheels, small bell sheaves, and large bell beam trunnions and links. Thirty-three points that require regular attention and at an elevation of 191 feet above ground.

Another view of the large bell beam (Figure 4) shows the pressure control valve of the lubricating system mounted on the adjacent stack at the left. When sufficient pressure is developed to operate this valve it makes contact to light a signal light at the central pumping unit, located in the hoist room below, to tell the oiler the job is done. This view also illustrates one method of grouping the lubricant measuring valves on top of the fulcrum with flexible outlet connections to the link pin bearings.

An alternate method for reaching these points is shown in the drawing of Figure 5. Here the lubricant

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measuring valves are mounted in a row on a suitable plate attached to the top of the fulcrum and the length of the flexible connections has been reduced, by extending the outlet piping closer to the point of lubrication.

All of the bearings, and especially the more important ones, should be lubricated at least once a day. Sometimes, however, the gas is so bad, men cannot even go up on the top for two or three days at a time, and often, when they do get up, they are only able to lubricate those bearings on the windward side of the furnace. Also it is against safety rules to attempt to lubricate when materials "hang up," or when the furnace is rolling or slipping, because of the great danger from gas and steam when the material lets go.

Safety rules further require that two men always go up on the top, one to do the actual greasing of the bearings, and the other to watch him and also watch for gas fumes. In case gas is encountered, the second man attempts to get the oiler out of the danger sone, and to signal a third man, who is on the job at the bottom, to bring aid. In the past, this hazardous method has long been accepted as one that could not be avoided.

A schematic layout of the lubricating system piping is shown in Figure 6 with the central pumping unit in the hoist house and the main lubricating supply lines leading up to the bearings on the furnace top.

The centralized lubricating system therefore delivers the lubricant under pressure to every bearing from one safe central point, each bearing getting the proper amount of lubricant and not a bearing missed. When lubricating by hand, even under the most favorable conditions, a bearing here or there is bound to be overlooked because there are so many and they are located in widely separated places. The lubricating system not only keeps the men entirely out of the danger zone, by providing complete lubrication from the hoist room, but it also eliminates one of the principal sources for gas leakage by giving proper lubrication to the packing seal on the distributor ring. Without adequate lubrication, this packing gland soon shrinks from the effects of the steam, gas, heat, and ore dust surrounding it. With a well-lubricated gland on the other hand, gas leakage is almost nil.

The rotary distributor shown in Figure 7 is located at the 143 ft elevation of this furnace and illustrates the lubricating system installation for serving 28 points of lubrication on this equipment. The lubricant measuring valves are installed in a circular ring of piping located just below the distributor support rollers with rigid pipe connections to both hold down and support rollers and including six points of lubrication to the distributor packing ring.

On many installations in the past, no provision was made for lubricating the packing gland or seal and it started to leak gas within a very few weeks. On some furnaces a few holes have been tapped around this ring and the oiler was expected to visit these points with a grease gun, but as usual the job was overlooked most of the time. With the advent of the lubricating system this sealing gland has been lubricated daily because the job was easy to do, keeping the packing soft and, of course, providing an effective seal against the escape of gas. We can report that on three furnaces, seals are still holding perfectly after a production on each furnace of well over a million tons.

Figure 7 also shows the main grease header piping running up the side of the skip hoist, accompanied by a separately wrapped steam line. The bundle of steam and grease lines is wrapped with felt and then covered with light gauge sheet metal or with roofing or building paper. A soft grease compounded with a low pour test oil, has been found to give very satisfactory service even in the 20 F below zero weather encountered a few years ago.

CENTRAL PUMPING STATION

Clean lubricant is served to all bearings through a closed system of piping, starting with the barrel transfer pump shown in Figure 8 and ending with the final

Figure 1 — Centralized lubrication serves the bearings of these stock line recorder sheaves which overhang the furnace 173 ft above ground.

Figure 2 — Fourteen points of lubrication on these small bell trunnions and links are served by the central system.

Figure 3 — Skip hoist bull wheels, small bell sheaves and large bell trunnions and links have 33 points requiring regular lubrication.

Figure 4 — Another view of large bell beam. Mounted on stack at left is a pressure control valve which signals to the oiler when sufficient pressure is developed to complete the lubrication.

bearing connection 175 feet or more away. The drum itself may be covered with flue dust, water or dirt but you still deliver clean, fresh lubricant from the original container right up to the bearings on the furnace top, without any chance for contamination.

Accurate control over the amount of lubricant delivered to each bearing also means a much cleaner condition for all the top machinery and good housekeeping around the top eliminates some of the hazards and gives the system a chance to do a good job.

The signal lights shown between the two pumping units in Figure 8 are operated by a pressure control valve (shown in Figure 5) located way up on the top beyond the last lubricant measuring valve. The control valve insures that, even on the coldest day of the year, sufficient pressure is developed to overcome the resistance in the supply lines and to operate every last lubricant valve, before the signal lights will operate to tell the oiler all bearings have been lubricated.

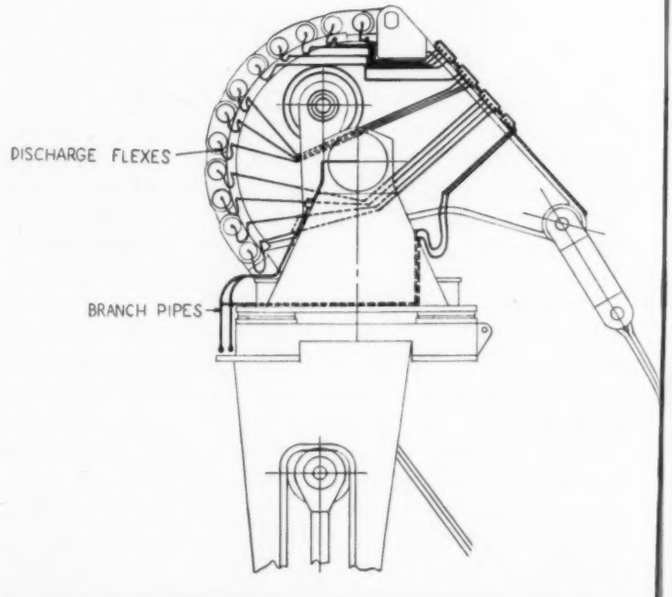
Early installations were made with the central pumping units located on the top or on an adjacent stove platform. However, experience has shown we must locate the pumping unit in the hoist room or at ground level, because only by so doing can we be assured that anyone will even visit the pump. Further with the pump at this location supervision is available to make certain the job will be done.

HEADER PIPING

As previously mentioned all main header piping should be accompanied by a separately wrapped steam tracer line and all bundled together and covered by a protective jacket of suitable insulating material. There has been a tendency on the part of some to install the lubricating systems with small diameter header piping requiring excessive pressures, and resulting in heavy resistance to the movement of grease. It only takes a few days of sustained cold weather to prove it is impossible to move lubricant in any of the lines and to show that small diameter piping is a false economy. Experience has shown the header piping should be at least 1¼ in. pipe size and preferably 1½ in.

Some of the first installations on furnace tops were made back in 1930 and covered only the 25 or 30 bearings on the rotary distributor. Following these early installations, the use of centralized lubricating systems has been gradually extended to include all of the bearings on the top. A recent check-up shows that more than 60 furnaces are now equipped and materials are on hand for many additional installations as soon as the work can be done.

Figure 5 — This sketch shows another method of reaching link pin bearings, using shorter flexible connections.



STOCK HOUSE EQUIPMENT

Several installations of manually operated systems have been made on the stock house line shaft bearings which operate the feed bins controlling the supply of materials to the skip. This makes an excellent application, for there are approximately 250 2 in. x 5 in. sleeve type bearings on the stock house line-shafting to be lubricated once in 8 hours. A manually operated centralized system of lubrication takes care of these 250 bearings in about 5 minutes, with each bearing getting a measured charge of lubricant — and not a bearing is overlooked. A 400-pound drum of grease is directly connected to the central pumping unit, and will last about 6 months, which means only two changes a year.

With the old hand method of lubrication, each of these bearings was visited three times a day, and if occasionally no one got around to do this large job that often, bearings wore out and had to be replaced. With the lubricating system, all bearings are served from one safe, handy place instead of climbing along a cat-walk to reach every one of the 250 points spread over a distance of 150 ft. On the basis of the oiler reaching 45 points by hand in an hour, the labor cost per point of lubrication, at 90 cents per hour, would be 2 cents per point.

Lubricating each bearing once per shift, of three times per day, for 365 days, the labor of oiling would amount to more than $5,000 per year for these 250 bearings. Even if the oiler could somehow lubricate twice as many bearings per hour the savings in labor of oiling would still be in excess of $2,500 per year and this saving alone would just about pay for the centralized lubricating system installation. The other economies of lower lubricant consumption, reduction in repair and maintenance costs, and the elimination of delays, would still be made and of course, the large labor savings would continue year after year. Centralized lubrication has also been employed for the lubrication of screening and weighing equipment and of course, many systems are being used for stock house cranes.

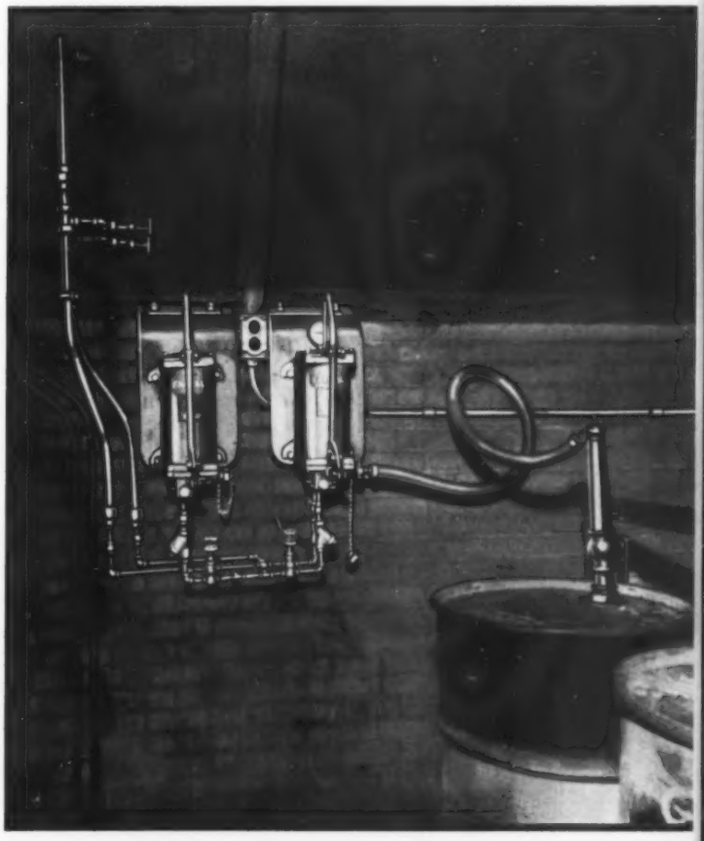
As a rule, records of repair costs in the average blast furnace department have not been broken down to show which items are chargeable to lack of lubrication and it is therefore difficult to get accurate and reliable data. In the past, many of the dangerous and hard-to-get-at sheave bearings just did not get lubricated at all. They were operated until they either froze or were completely worn out and a major repair or replacement was required. A saving of but $500 in these repairs, would pay for a substantial part of the cost of a lubricating system. Centralized lubricating system installations on blast furnace tops, however, have not necessarily been made to save repairs, but rather to insure continuous operation and to eliminate the hazards of hand oiling.

With the job of lubrication properly taken care of by the system, it is no longer necessary to rely on the inexperience of an oiler for mechanical inspection of the equipment. Weekly inspections of the equipment and of the lubricating system can be made by a competent man from the mechanical department and, further, given daily lubrication, it has been found that the equipment does not wear out so rapidly and the problem of inspection has been materially reduced.

Also, while centralized lubrication on furnace tops is not employed primarily to save oiling time, it is a fact that the labor of oiling is reduced to a minimum. With two and sometimes three men, at least 30 minutes was required to lubricate all bearings, whereas with the

Figure 6 — There are 28 points of lubrication on this revolving distributor top, all lubricated by the central system.

Figure 7 — These two manual pumping units supply grease directly from the drum container to the various points to be lubricated on the furnace top.



centralized system one man does the job from the hoist room in a few minutes. It is true that the saving in man hours may not be sufficient to reduce the total number of oilers, but the man hours are saved and they are available to perform other work.

We have tried to point out that lubricating bearings on top of a blast furnace is a tough job because of the existing conditions and I believe we can all appreciate that if we had to do the job, we would not be too anxious about going up there either. With a central pumping unit located in the hoist house however, lubricating from 50 to 100 bearings way up on the top, becomes a very simple and easy job to do and therefore, it gets done.

As a result of giving all bearings regular attention, centralized systems do a good job of lubrication, insure production, preserve equipment, eliminate down time, save critical materials and provide complete safety for the oiler.

DISCUSSION

PRESENTED BY

W. E. HYDE, Lubrication Engineer, Wheeling Steel Corporation, Steubenville, Ohio

S. C. GRIFFITH, Lubrication Engineer, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania

C. C. PECU, Lubrication Engineer, Bethlehem Steel Corporation, Lackawanna, New York

A. J. JENNINGS, Vice-President, The Farval Corporation, Cleveland, Ohio

FRANK JOHNSON, Vice-President, Trabon Engineering Company, Cleveland, Ohio

W. H. MANDY, Lubrication Engineer, The Texas Company, Pittsburgh, Pennsylvania

E. J. EHRET, District Manager, The Farval Corporation, Chicago, Illinois

W. E. Hyde: We have a furnace off for a rebuild at the present time which is lubricated with a centralized system. After nine years of service we found all feeders and pump in excellent condition. The only changes to be made are the installation of a more modern time clock, and the placing of a strainer between the drum pump and reservoir on the system for the elimination of scale and foreign matter, both of which will cause failure in a centralized system if proper provisions are not made.

S. C. Griffith: The benefit of automatic lubrication is quite generally recognized and quite generally accepted. However, to reap those benefits over a period of time, there are two things that must be considered: First of all, the thoughtful engineering of the original installation — and I choose that word "thoughtful" with one idea in mind. The system must be put in correctly to make it last. Secondly, to retain those benefits that automatic lubrication can give, careful maintenance is necessary — the kind of maintenance wherein the small elements receive their full share of attention.

C. C. Pecu: I am perfectly in accord with all automatic lubrication. I find that machinery wears much longer when lubricants are applied automatically.

Mr. Jennings' paper covers not only proper lubrication but shows how easily the many hazards can be eliminated by use of automatic lubrication machinery. I am sorry to state that our plant does not have any such devices on their furnace tops. While all are aware that it is right, we have not had the proper time, during the last few years, to install such equipment.

I would like to ask Mr. Jennings how he insulates the steam tracer lines so as not to overheat the grease. While nearly all northern plants do have tracer lines and are insulated, it is well to know how the manufacturers of this machinery would insulate if they had a contract to install such equipment in a cold place.

A. J. Jennings: The usual practice is to wrap the steam line itself with felt and insulate it from the grease line. This may seem to be contrary to what you are trying to accomplish, but we have found that if you have the steam line adjacent to or in contact with the grease line you would fry the oil out of the grease. In order therefore to make sure you do not get too much heat, the steam line should be insulated from the grease line and then the entire nest of pipe wrapped with felt one inch thick.

Frank Johnson: I disagree with Mr. Jennings in one or two points he brings out in his paper, but I am not going to argue those two points. There is one point I could bring out. We have lubricated about forty blast furnaces, and the tendency has been, especially in the last year, toward automatic lubrication. By automatic, I mean power-driven units, not only on the furnace itself but on the skip hoist engine which is a small unit. But they are coming to the motor-driven pump, both on the skip hoist engine, and they are adding the motor-driven pump to the furnace itself. That is one of the trends in the last twelve to eighteen months.

A. J. Jennings: I felt I should say something in regard to the use of the power-driven units. We also have over forty furnaces equipped, and so far only one has had the power-driven installation on it, and that is the one, by the way, that Mr. Hyde said had run for nine years and five months without any difficulty.

I am inclined to agree with Mr. Johnson that the power unit has its advantages, but you also face the dollars and cents, and a great many people have felt that for the matter of a couple of minutes that it takes to pump a hand pump, it might be difficult to justify the more costly installation of the power-driven pump.

It has been our experience that the bearings on the hoisting equipment in the hoist room should be served by an automatic system, because they require more frequent application than would be needed on the furnace top itself.

We also find, even with the manual jobs, there are some sheave bearings that do not need lubrication as often as the others, so where possible they have been connected onto a branch line, which is cut off by means of suitable gate valves. This set-up permits you to lubricate all the bearings, with the exception of those on the branch line, once each shift, while the pin or sheave bearings are lubricated once a week perhaps.

(*Please turn to page 56*)

A-C AND D-C DRIVES FOR *Draw Benches* AND *Wire Blocks*

. . . . electrical equipment for draw benches and wire blocks varies with production requirements, power supply, flexibility, first cost and plant policies . . . . the pros and cons of the various systems are discussed in this paper . . . .

by R. A. Geuder, MANAGER
METAL INDUSTRY APPLICATION
RELIANCE ELECTRIC AND ENGINEERING COMPANY
CLEVELAND, OHIO

▲ DRAW benches and wire blocks are rather closely associated machines from the standpoint of function as regards the material being put through them. In other words, both wire blocks and draw benches reduce the diameter or cross section of the rod or pipe by drawing it through a stationary die. The wire blocks by definition confine themselves pretty well to rod and wire, solid cross section material. The draw benches are used either on tubes, pipe or rod and wire.

In order that this discussion may not become too complex, we shall neglect any details specifically differentiating between rod and tubes and confine our investigation to the application of the electrical equipment, the wire blocks and draw benches as such.

Quite naturally there are many reasons why different types of electrical apparatus are used. Production requirements, electrical power supplies available, flexibility, first cost and individual plant policies often dictate the electrical equipment to be used.

In the discussions that follow wherever advantages and disadvantages seem to present themselves, they will be presented from a broad viewpoint and, of course, therefore, not reflecting individual specific studies.

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 28-30, 1943

DRAW BENCHES

Figure 1 illustrates a familiar type of draw bench. On this type the chain runs continuously at the desired speed and the operator manually grips the pointed end of the material with the tongs and after setting the grip, drops the end of the tongs into the draw chain. After the material has been drawn, the tongs are tripped and returned on a conveyor or track to the operator. Some of these conveyors are electrically driven and some are purely gravity.

On these particular types of drive, direct-current adjustable-speed motors are used largely with non-reversing dynamic braking controllers. Dynamic braking is for safety reasons and aside from heavy duty equipment the control is perfectly standard.

The problem in so far as the bench is concerned is that the speed shall not be so high as to pull off the pointed end of the material when the tong is dropped into the chain. High production benches like these usually run at a fixed speed which is the optimum speed for insurance against pulling off the pointed end of the material compared against rate of draw for high production in feet per minute. Where the optimum speed is too much of a compromise in favor of pulling off the pointed end of the material because of the shock to it

when the chain takes hold of the tong, it is frequently necessary for the operator to arbitrarily drop the speed of the chain before the tongs are grabbed by the chain and then to accelerate as soon as the material is started to be drawn.

Figure 2 illustrates how these features are accomplished in the more modern bar benches. It will be noted that the manually-operated tongs have been replaced by mechanically automatically-operated tongs mounted on a carriage. Typical operation of such a bar bench is as follows:

Let us assume that one bar has just been drawn and that it has been discharged off the side of the bench and, of course, the carriage is stationary, and the chain is going at slow "hook on" speed.

The operator presses the carriage return pushbutton which will cause the carriage motor to start and bring the carriage back toward the die head. The carriage, however, is interlocked with the skid arms or cross arms so that they must be out of the way before the carriage can be returned. These arms are operated by air cylinders and solenoid-operated valves electrically interlocked with the carriage. As the carriage approaches the die head at full speed, a limit switch is operated in advance of the head to slow the carriage down to some much lower speed preparatory to stopping prior to reaching the die head. A second limit switch then actuates the stopping which is a combination of dynamic braking and shoe braking on the carriage motor. This final stop limit switch is positioned in such a way as to bring the carriage up to the die head without bumping.

As the carriage reaches the die head, the jaws are tripped automatically to grip the pointed ends of the bar extending through the die and the hook drops in the chain. The tension on the bar through the linkage of the carriage keeps the grip tight on the bar. Moreover, the gripping of the bar and the dropping of the hook into the chain actuates a load switch to bring the speed of the chain up to the desired drawing speed.

The "draw" is continued at this maximum desired speed and as soon as the ends of the bar leave the die, the tension on the tongs is released which releases the tongs and also releases the hook from the chain. As the draw is being made the cross arms or skid arms have been coming in behind the carriage to support the drawn bar and as soon as the bar is released by the carriage, it skids across and is deposited beside the bench. Also the release of the bar from the carriage reduces the motor load so that a load relay drops the chain speed back down to the "hook on" speed.

The completed cycle has now been made and the carriage remains stationary awaiting the operator to initiate the next cycle.

From an operating standpoint there are several features which are essential to quality production:

1. A drawing speed range of sufficient magnitude to not only give production but also to give some control of the physical characteristics of stresses caused by rate of draw and effectiveness of lubrication.
2. A high speed carriage return with satisfactory control of stopping without an abnormal bump against the die head.
3. A low speed for starting the draw as insurance against damage to the pointed end of the bar and also to allow time for the lubricant to prepare conditions for proper relationship of bar and die.
4. Insurance against loss of torque during acceleration from "hook-on" speed to "drawing" speed since a loss of motion of the bar through the die results in the marking of the bar.
5. Automatic control carefully interlocked for operational sequence and safety and design to give maximum man hour production with minimum attention.

TYPES OF ELECTRICAL DRIVE

There have been numerous applications of electrical equipment on draw benches and among the outstanding ones are:

A-c motor, single speed
A-c motor, 2, 3 and 4-speed non-accelerating
A-c motor, 2-speed accelerating
A-c slip-ring motor
A-c motor with eddy current clutch
A-c motor driving hydraulic system
D-c adjustable-speed motors with 2:1, 3:1 or 4:1 range, with or without shunted armature, low "hook-on" speed
D-c motors operating on variable-voltage with or without additional field weakening.

There are undoubtedly some other combinations or modifications of the above list since probably no one single manufacturer has been intimately associated with the complete development of all the various types of electrical drives.

A-c squirrel-cage single speed — This type of draw bench drive is probably the simplest form wherein the carriage return motor and the main chain motor are both single speed squirrel-cage motors. Obviously no interlocking can be provided for slowdown and speedup between "hook-on" and drawing speeds and since the carriage return motor is single speed, there is only the one limit switch for stopping the carriage at the die head. The interlocking of the arm and the initiation of the control from the operator's standpoint are, however, quite common to all drives.

The virtue of a single speed squirrel-cage a-c motor drive must obviously be:

1. Low first cost.
2. Practically single purpose operation of one type or at least narrow range of products.
3. An economic balance between optimum drawing speed and safe "hook-on" speed in terms of satisfactory production for the investment.

A-c squirrel-cage motors, 2, 3 and 4-speed non-accelerating — The multi-speed a-c motor non-accelerating drive is one step towards wider diversification of products to be drawn than the single speed motor. However, on the non-accelerating drive there is still no provision made for change from a low "hook-on" speed to a higher drawing speed and at any selected speed the bar is gripped and drawn at that same speed. Frequently with this type of bench the carriage return motor is a 2-speed motor giving a high speed return and then a slowdown before the carriage reaches the die head. Interlocking of skid arms, etc., is essentially the same as in other drives. The selected drawing speed must be

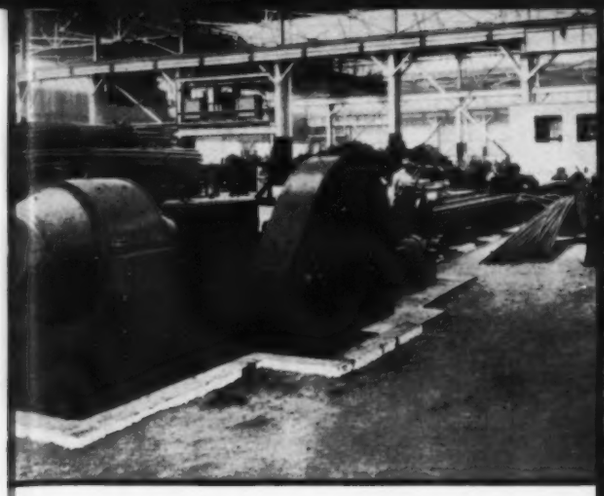


Figure 1 — Draw bench with draw chain running continuously at desired speed. Material is manually gripped with tongs which are then engaged into the chain.

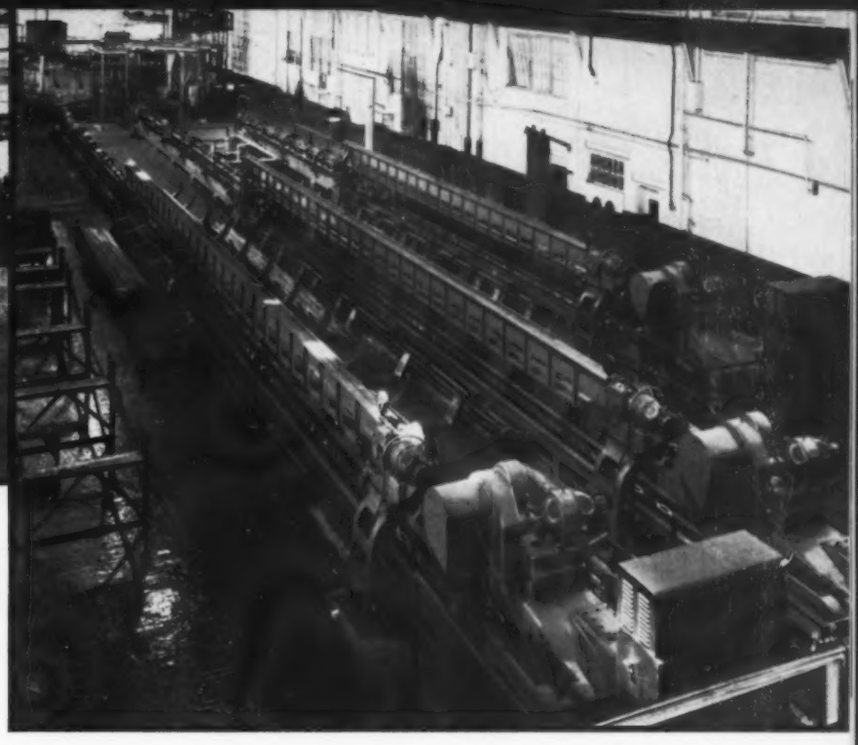


Figure 2 — In these draw benches, automatic mechanical tongs mounted on a carriage grip the bar. Carriage is then engaged with chain which in turn is speeded up from hook-on speed to drawing speed. Entire cycle is automatic after initiation by single push button.

low enough for "hook-on." The advantages of such a drive are as follows:

1. Relatively low first cost.
2. Provision for some selection of different drawing speeds when only a-c power is available.
3. Wider range of products made possible by different available drawing speeds.
4. Possible economic balance between first cost and range of products and production requirements.

A-c squirrel-cage motor, 2-speed accelerating type — The a-c squirrel-cage motor type of the 2-speed design with accelerating features is the first approach towards a bench which allows the desirable low "hook-on" speed with a desirable higher production drawing speed. Here again 2-speed motors are used on the carriage return much the same as the previous case with the lower speed being used for a slowdown speed prior to reaching the die head. On the chain motor itself, however, the control and motor design provide for a transition from a low "hook-on" speed to a higher drawing speed without the loss of torque which would be present during the normal transition from low speed to high speed with standard motors and control. It is believed that to date only 2-speed motors have been used for this purpose and in most cases they have been a 2:1 range as, for instance, 450/900 rpm or 600/1200 rpm. This particular design of equipment (Figure 3) is an interesting one which may be more fully described during the discussion. Briefly, as will be seen by the sketch, the transition involves the energization of all of the motor windings for an instant before the next combination of pole connections are completed to give the higher speed. In this way there is apparently no loss of torque (although it may be somewhat less than full load) and to some extent the current peaks during the transition are lower than they would be on a standard typical 2-speed motor and controller. The advantages of this particular type of a-c motor drive are probably as follows:

1. Provision for low "hook-on" speed and higher drawing speed with only a-c power available.
2. Increased production because of ability to draw at high speed without danger of too high a "hook-on" speed.
3. Probably an economical balance between cost of equipment, power supply available, and range of products.

A-c slip-ring motor drive — Some speed range could be accomplished, of course, with a slip-ring motor on the main machine drive. However, the ordinary slip-ring motor with sufficient secondary resistance to drop its speed to some low value has a very poor speed regulation. It takes an excessive amount of secondary resistance to drop the speed of the unloaded chain to some low "hook-on" speed. With that amount of resistance present in the secondary circuit of the slip-ring motor, as soon as the hook drops in the chain and load comes on the slip-ring motor, it slows down or actually stalls before the accelerating contactors can cut out the secondary resistance. In general, the slip-ring motor drive is not applicable with its ordinary controller for a range of speed between "hook-on" and drawing speed, but is rather a compromise to give some range of drawing speed, particularly where the "hook-on" speed is not too critical. The points in favor of such a drive are probably as follows:

1. Some choice of drawing speed.
2. Relatively low cost equipment from only a-c power supply.

A-c slip-ring motor with unbalanced primary control — The use of the a-c slip-ring motor for draw bench service is, of course, desirable from a first cost consideration and from a power supply standpoint. Many of the disadvantages indicated above are minimized by the use of a controller which provides a controlled low speed

for "hook-on," which low speed has fairly good load regulation, and from which low speed, acceleration, without loss of torque, is possible. Figure 4 shows the typical arrangement of the control and motor secondary windings which may be more completely covered in the discussion following this paper. Briefly, the auto-transformer impresses a voltage on one phase of the secondary which is less than the other phases. The net result is apparently the effect of two rotating fields, one rotating in one direction and one rotating in the other, and the resultant torque of the motor being the vectorial sum of the two influences. Figure 5 shows the typical speed torque curve available for the low "hook-on" speed. Note that the curve is rather steep and that there is a positive no-load speed at about 25 per cent of synchronous speed. It should be pointed out that the heating at this low speed is somewhat in excess of the heating that would correspondingly be present in the slip-ring motor with ordinary secondary resistance producing the same torque at the same low speed. The advantages apparently are:

1. A positive low "hook-on" speed.
2. Some reasonable range of drawing speeds.
3. Smooth acceleration from "hook-on" speed to drawing speed without loss of torque.
4. Possible economic advantages and a compromise between limited drawing speeds, first cost and production demand.

A-c squirrel-cage motor with eddy current clutch — Several designs of eddy current magnetic slip clutches are available on the market. If the excitation of these clutches is adjusted, then the clutch will develop rated torque at a speed wherein the combination of flux and relative speed of driver and driven half is such as to develop the necessary torque. To a certain extent this type of drive is somewhat similar to the slip-ring motor drive in that a very weak excitation on the clutch to get low speed no-load operation for gripping results in a tendency to stall before re-acceleration can take place. There are some automatically controlled clutches which in effect correct for load changes, but the primary usefulness of the eddy current clutch drive would appear to be in the direction of getting adjustable drawing speeds without too much emphasis being put on acceleration and deceleration between a low "hook-on" speed and the desired drawing speed. The inertia of the clutch plus the possible inherent time constant of the exciting fields make the problem of rapid acceleration difficult. Moreover, rapid deceleration is not readily accomplished except with some braking means. On a rapid-operating bench, rapid deceleration to a low "hook-on" speed is as important as rapid acceleration which would seem to assign a difficult job to the eddy current clutch type of drive if those requirements persisted. The advantages of this type of drive would seem to be as follows:

1. Adjustable draw speed over fairly wide ranges with maximum torque limited by torque of the squirrel-cage driving motor.
2. Moderate first cost with only a-c power available.
3. A possible economic balance between the requirement for low "hook-on" speed and higher drawing speeds as balanced against probable production requirements of material that would allow some of these compromises.

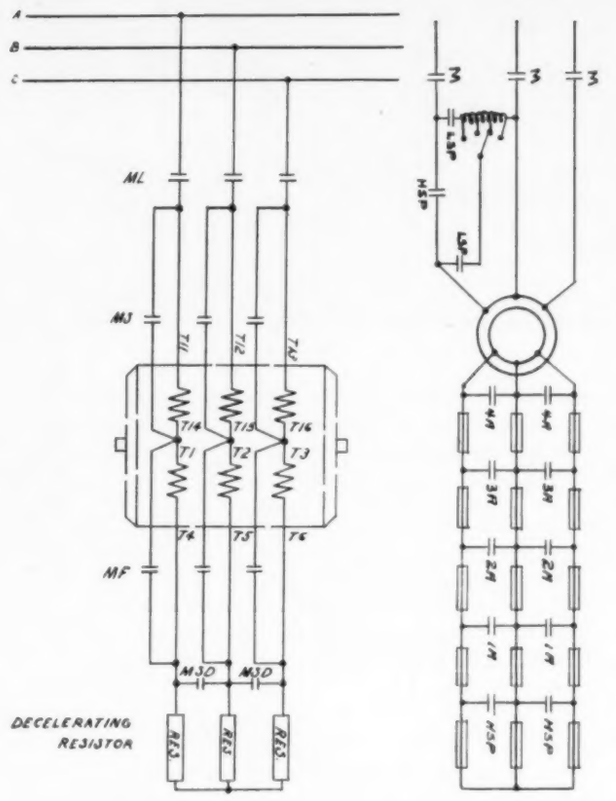


Figure 3 — (left) Diagram showing connections for draw bench drive using an a-c squirrel cage motor of two-speed accelerating type.

Figure 4 — (right) Typical arrangement of control and motor secondary windings for a-c slip-ring motor with unbalanced primary control.

A-c squirrel-cage motor driving hydraulic units — When a hydraulic system including a driven pump and a receiver hydraulic motor is powered by a single speed a-c motor, the electrical problem is fairly simple, being confined essentially to interlocking of motion with solenoid valves instead of contactors for the electric motors themselves. The hydraulic scheme would fit most of the requirements giving a wide drawing speed range as well as a low "hook-on" speed and does provide for rapid acceleration and deceleration to take full advantage of the low "hook-on" speeds and higher drawing speeds. This system, however, includes a fair amount of installation cost as well as a relatively high first cost and probably there are some sort of conditions where this installation might be warranted, but the chances are that the first cost plus installation costs will exceed any other type of drive. Its advantages appear to be:

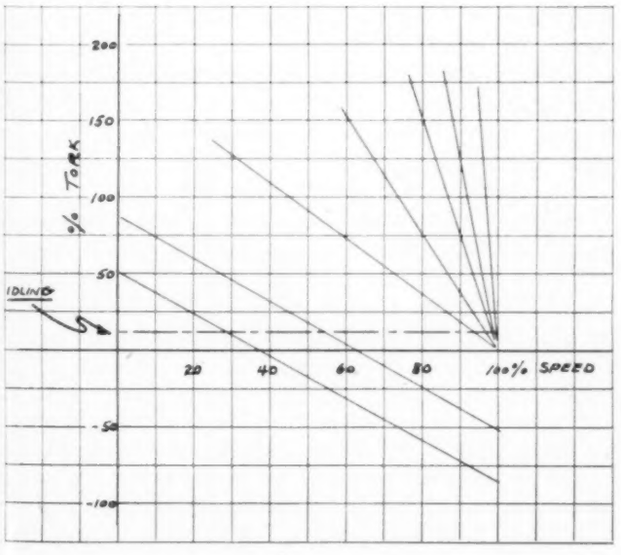
1. Low "hook-on" speed with a wide range of high drawing speeds.
2. Rapid acceleration and deceleration between "hook-on" speeds and drawing speeds.

3. Flexibility to cover a wide range of products with limited torque control.
4. High first cost must, of course, be economically offset by high production ability which might show up in production requirements involving short lengths of bars.

D-c motor with 2:1, 3:1 *or* 4:1 *speed range* — The use of direct-current motors having adjustable speed range to cover the production requirements have been and probably will continue to be the basis against which all comparisons are made. The fact that the direct-current motor can be very readily controlled remotely for preset speeds and can with shunted armature control provide economically a very low "hook-on" speed, and can with proper selection be of such a character as to give rapid acceleration and rapid deceleration would appear to cover the draw bench requirements very completely. One problem, however, is present on the adjustable-speed direct-current draw bench motor drive and that is that at lower speeds the motor torque is proportionately higher than at higher speeds. The draw bench is rated in pounds pull. The horsepower is calculated with the rated pull at an intermediate speed. The motor is supplied at this rated horsepower but with a speed range above and below the intermediate. This means, then, that the adjustable-speed d-c motor with constant horsepower rating over its speed range could overload the chain at low speed and if full chain pull is required at high speed, the motor will be overloaded. Full protection of chain and motor over the entire speed range is, therefore, difficult to attain. The advantages, however, of the adjustable-speed d-c motor appear to be:

1. Wide drawing speed range.
2. Low "hook-on" speed.
3. Smooth acceleration without loss of torque from low "hook-on" speed to preset desired drawing speed.
4. Ease of remote control for preset drawing speed.
5. Moderate first cost with direct current power available.
6. Flexibility both as to safety, control of acceleration rate and deceleration rate, and ease of establishment of a modified "hook-on" speed when necessary.

Figure 5 — Typical speed-torque curve available for low hook-on speed with unbalanced primary control of a-c slip-ring motor.



D-c motor with variable-voltage supply — From the standpoint of overall flexibility with only a-c power available, the direct-current motor with variable-voltage supply offers many interesting angles. The range of drawing speeds can be wider than with the conventional field control direct-current motors. The "hook-on" speed can be set as low as desirable and, in fact, can be zero with a smooth pickup on acceleration to the desired operating speed. Inasmuch as the motor is a constant torque drive, the problem of matching motor torque to chain capacity is straightforward and simple. In addition, since there is probably no compromises between chain capacity and motor torque, the ultimate frame size of the chain motor will be smaller, resulting in lower WR^2 of rotating parts with the possibility of more rapid acceleration and deceleration with its associated production output.

Obvious advantages are as follows:

1. No overloading of chain at any speed.
2. A wide drawing range with only a-c power available.
3. Low "hook-on" speeds as low as zero if desirable.
4. Smooth acceleration from zero "hook-on" speed to preset operating speeds.
5. Rapid acceleration and deceleration between "hook-on" speeds and drawing speeds.
6. Uniform torque control over entire speed range.
7. Ease of remote control for drawing and "hook-on" speed selection.
8. Control handles only light (field and excitation) current and does not make or break heavy armature current, resulting, therefore, in lower maintenance.
9. Overall flexibility from a-c power with no practical limits on speed range or horsepower capacity.

MODERN WIRE DRAWING MACHINE

Wire blocks could probably be divided into any number of categories but they do seem to fall fairly well into the following classes:

1. Single head wire blocks.
2. Single motor-driven machines of the cone, cone tandem or straight tandem class.
3. Multiple head continuous blocks.

Single head bull blocks — Many years ago the wire drawing industry confined its equipment primarily to the type of wire drawing equipment shown in Figure 6. Here a single motor, through suitable gearing, drove an entire line of individual blocks. Each block could be clutched to or unclutched from the main drive. In such an arrangement as this, irrespective of the type of wire being drawn, it was obvious that all wire was being produced at the same speed per minute, but naturally the feet per minute selected represented then a compromise between the highest desirable speed for smaller wire and the lowest necessary speed for heavier wire and rod. The individual wire block, illustrated in Figure 7, was one of the early steps in the direction of

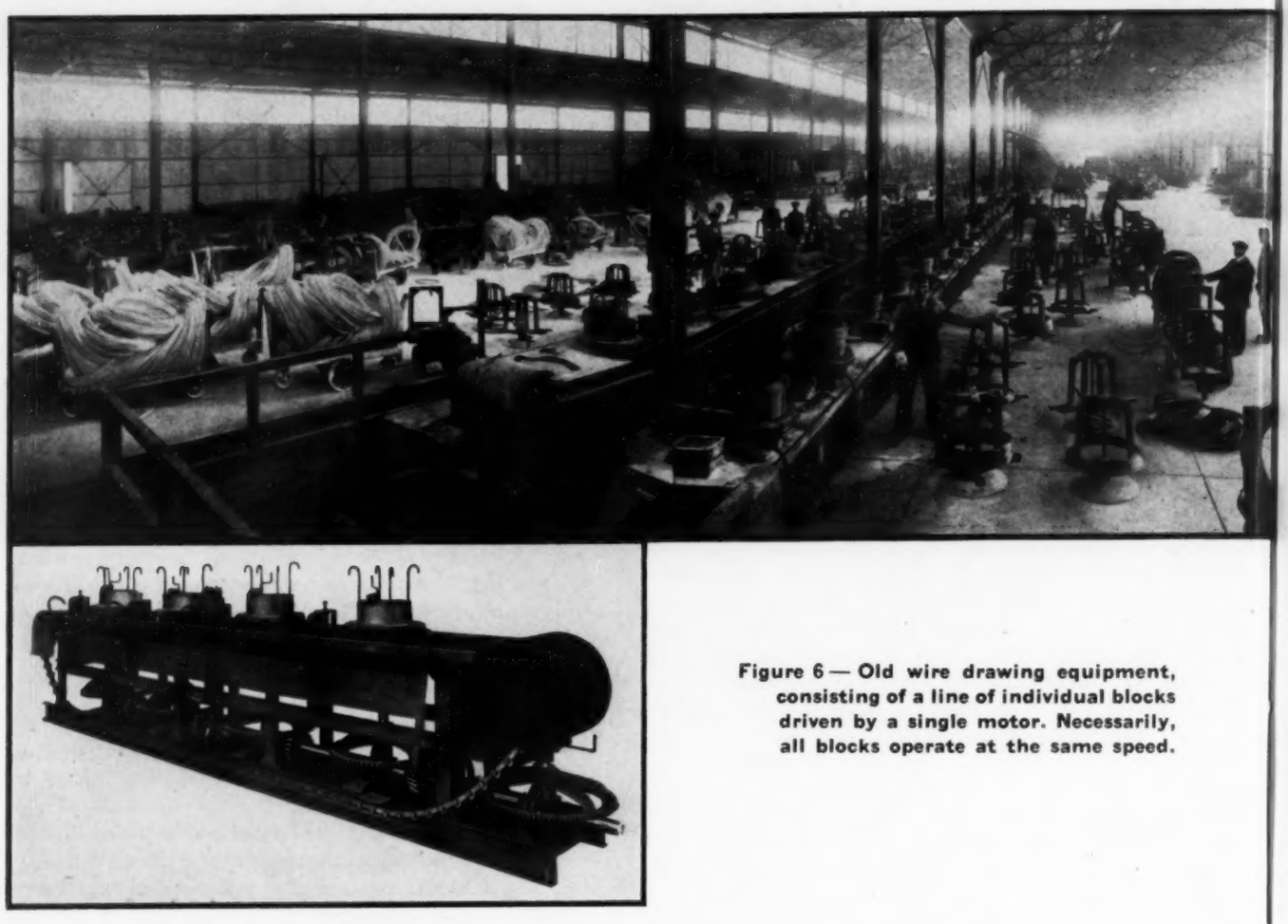


Figure 6 — Old wire drawing equipment, consisting of a line of individual blocks driven by a single motor. Necessarily, all blocks operate at the same speed.

higher production wire block machinery. Here individual blocks with its own individual motor drive could start and stop effectively without danger from operating blocks on either side and could give a sufficiently wide speed range to cover all the wire size that could economically be handled by a single machine such as this. Adjustable-speed direct-current motors were used almost exclusively for sound reasons. First, the starting torque on such a block is considerably above the full load running torque and the motors had built into them special starting series windings and characteristics. The control likewise had to make use of this special starting series. Figure 8 illustrates a typical arrangement of control on a bull block direct-current motor. Advantages of the individual drive of this type are as follows:

1. Speed range to match the product being drawn — heavy wire at low and light wire at high speed.
2. Safety, because of the elimination of interference from operation on either side with their attendant danger.
3. Extra heavy starting torque and smooth acceleration up to present running speed.
4. Quick stopping with dynamic braking for safety.
5. Low speed start to prevent pulling off the pointed end of the rod.

From the above reasons it appears that adjustable-speed direct-current motors provide the best answer to this type of application. Certainly other types of equipment might be used, but in general it is safe to say that the great majority will be and are individual adjustable-speed direct-current applications.

Single motor-driven machines of the cone, cone tandem or straight tandem type — The terminology "single motor-driven machines of the cone, cone tandem or straight tandem class" might be confusing unless we add to it that this machine might contain several capstans, but all capstans are geared rigidly together without any means of compensation between them except slip. This will satisfactorily contrast it with a multiple head continuous machine where some sort of compensation is provided between heads. On the single motor-driven machines of this class there is a wide variety of electrical drive employed. In general, the main heads are driven through interconnected gearing from a single motor. The wire as it is drawn through the last die is rewound on a block or spool which is either driven by a special takeup motor or through a special take-up means driven from machine.

This type of machine is usually one of a battery of many and since the wire is generally small, the time of operation as compared to the time of starting and stopping is great. The starting and running problems parallel the draw bench and single head single motor wire machines.

Starting with the a-c single speed motor with its attendant low first cost and restricted range of products, we can follow right on down the list as was presented in the draw bench wherein the multi-speed a-c motor gave some advantage in speed selection, but was not as smooth for acceleration as the slip-ring motor. The motor with eddy current clutch competes with the slip-ring motor but except for the automatic speed

control variety offers no advantages. The hydraulic system is very flexible but is expensive in first cost and installation. The adjustable-speed d-c motor offers much in the way of flexibility, low inching speeds, smooth acceleration and moderate cost if d-c power is available. A variable-voltage drive with only a-c power available is moderately priced, reasonably easy to install and offers a flexibility to meet a very wide range of product and the ability to handle them smoothly and quickly.

The take-up means which winds the finished wire on a spool has been in many cases a special slip-ring motor with secondary resistance to give a desired speed-torque curve of a d-c heavily compounded motor which will result in steady tension on the wire. In some highly specialized cases this take-up motor has been a special squirrel-cage motor with a skewed core to give the speed-torque characteristic desired (Figure 9). The control usually provides for a rate of acceleration on the main head which is an optimum for reasonable insurance against breakage of wire and which also will allow for a smooth acceleration of the take-up reel mechanism. Some controls actually were built with an adjustable rate of acceleration at the selection of the operator, so that different grades of wire might be handled at different rates of acceleration. Obviously with a capstan type of drive, it is necessary to keep the wire snug around the capstan; therefore, it is desirable to have the take-up unit start a little ahead of the rest of the machine in order to establish that tension on the wire.

Multiple head continuous wire blocks — Multiple head continuous blocks are in effect a group of compensated individual blocks. Note that as the wire is drawn through each die, the cross section of the wire is reduced and its length increased. Since the same amount of material, or in other words, the same number of pounds of material must pass through the dies, it is obvious that the entry feet per minute will be slower than the exit feet per minute. This means that as we progress from die to die, we increase the feet per minute travel of the wire. The multiple head wire blocks are so arranged that they provide for an increased lineal surface speed as the wire progresses from die to die. Obviously

Figure 7 — The individual wire block, with individual drive, was one of the early steps toward higher production wire machinery.

it is necessary that there be some relationship between two adjacent heads and that there be some means of compensation between the two, assuming that the gear ratio is not perfect for the reduction in cross section caused by the die. There are in general use two kinds of multi-head continuous wire machines. In one type the individual heads are all driven from a common motor through suitable gearing so arranged that the heads increase in speed as the wire progresses from die to die. The compensation for error between the speed of the head and the wire speed on either side of the die is taken up in an accumulator. In this particular type of block each successive head runs slower in feet per minute than is represented by the difference in ratio

Figure 8 — Typical arrangement of control for a bull-block d-c motor driving an individual wire block.

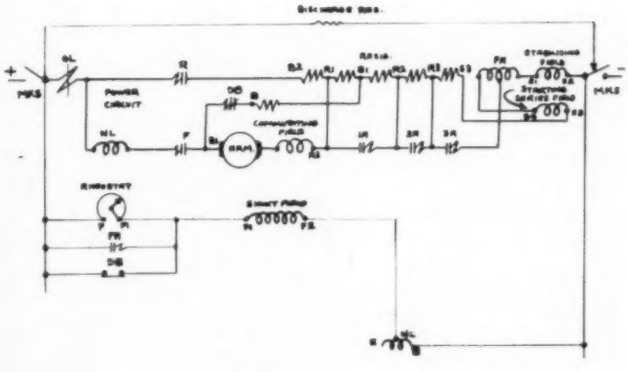
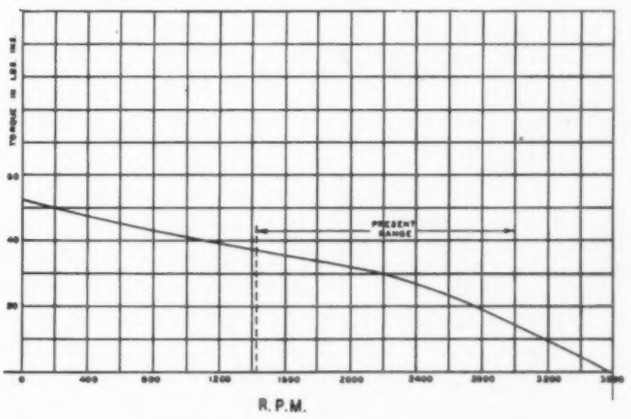


Figure 9 — Speed-torque curve for take-up motor for rewinding wire coming from machine of cone or tandem type.



between entrance and exit feet per minute on either side of the die. In this way, each head slowly accumulates excess wire footage by turns, building up along the vertical arms that support the bundle. This type of wire block can use any or all of the individual heads and as has been shown the compensation for wire reduction is mechanical. The drives may be single speed a-c squirrel-cage motors, although there have been many direct-current motors applied where adjustable speed was a real production advantage. Here again we can evaluate the various motor drives from the single speed a-c motor down through the hydraulic system, magnetic clutch and constant and variable-voltage d-c schemes with the same general conclusions as developed for the draw bench and single motor-driven cone type, etc., machines.

Multiple head continuous machines with multiple motor drive — Another type of wire block of the multiple head type is one incorporating individual motors driving each head. Figure 10 illustrates this type and also shows the type of synchronization between the several heads.

In this type of machine the individual motors that drive the individual heads are essentially duplicate motors. Gearing between the motor and its respective head is such as to accommodate the average reduction at each die. However, due to wearing of dies, size selection of dies, type of material, etc., the individual heads must operate at a variance from the average. The individual motors must operate the head at the proper relative speed. To accomplish this, there exists between each head a take-up dancer roll arrangement. The dancer roll is connected to a rheostat which operates in the field of the preceding block motor. If we number the blocks from start to finish, as No. 1, No. 2, No. 3, etc., we will notice that the dancer roll between No. 2 and No. 3, for instance, controls the motor driving No. 2, so that if block No. 3 tends to run faster than block No. 2, taking into account the die reduction, the wire loop around the dancer roll between No. 2 and No. 3 will gradually disappear. In so doing, it will pull the dancer roll which adjusts a rheostat in the field of motor No. 2 to cause it to speed up and re-establish the proper relationship between No. 2 and No. 3.

Because of operating requirements, because of the wide variety of products, and because of physical characteristics to be obtained, the individual motors on such a block have speed ranges anywhere from 2:1 to 4:1. This speed range on a typical machine is provided to give an adjustable delivery speed as well as synchronization between blocks and as well as a means of taking up any eccentricities due to unusual or peculiar die setup.

Since many of these wire machines operate at fairly high speed (common wire products of small sizes ranging up to 2000 ft per minute) it will be seen that the dancer roll rheostat must be such as to provide a quick response for the motor. Similarly the motors must of necessity be able to respond before the wire looped on the dancer roll is drawn taut. A combination of these requirements has represented quite a long development over the past years, until at the present time motors are provided with special speed drop characteristics, overload capacities, and overspeed ability.

Figure 10 — One type of multiple-head continuous wire drawing machine with multiple motor drive.

In general, the motors on this type of machine are handled as a single armature. All motors are started together and are dynamically braked through a common resistor. Safety devices such as snarl switches and loose wire switches provide for quickly stopping the block to prevent further wastage of wire or danger to operator. The apparent advantages of this type of electric motor drive are as follows:

1. Adjustable delivery speed.
2. Smooth acceleration and deceleration in tandem.
3. Accommodation for unusual die setup.
4. Accommodation for proper synchronization during running conditions.
5. Quick stopping by dynamic braking in the event of wire breakage or snarls.
6. Truly continuous operation under varying conditions.

As mentioned above, a part of the speed range of the individual motors on the multi-motor continuous machines is used for lineal speed control. In other words, on a 4:1 field control motor with normal die setup, the delivery speed range of the machine might be as much as 3:1 and the balance of the field range of the motor used for synchronization. This means, however, that we are confined to a speed range within the normal range of adjustable-speed direct-current motors and that when we are operating at the high end of the speed range, the motors are operating with weak fields and distorted flux paths. Moreover, they are operating at their highest speed with least torque available per ampere, with the result that the speed of response where it should be the greatest is the least. In addition to this, there are many times requirements put up to the wire mill operating department for producing a particular characteristic in the wire which can be obtained only by specific cooling means, and which cannot be obtained at high speeds. As a matter of fact, sometimes these characteristics cannot be obtained at the basic speeds for which the block was designed.

Moreover, there are many occasions when multi-motor blocks are to be installed in plants having a

restricted amount of direct current power or none at all. When such circumstances present themselves, the use of variable-voltage on multi-motor wire blocks seems to be a logical answer. By so doing a great part of the lineal speed range of the wire block can be obtained by voltage control, leaving only enough field control on the motors to compensate for peculiar die setup and for synchronization. The use of variable-voltage inherently provides d-c power required for such a block and in addition opens up the possibilities of extremely wide operating speed ranges, perhaps even in excess of what the operating department may have thought was required.

Moreover, since most of the field control range of the motor normally used for lineal speed control can be eliminated, it means that at all times the motors are operating at a stronger field flux condition, and that they can respond more rapidly to necessary corrections because of the greater torque per ampere available.

Since a variable-voltage system is being considered, it appears after intensive study that an economical combination of motor generator set can be applied which will make use of overvoltage for high speed light load conditions, and provide normal voltage for heavier load normal current operations.

The advantages of variable-voltage applied to multi-motor wire blocks, therefore, appear to be:

1. Extremely wide operating speed range.
2. Smooth acceleration through generator field control.
3. Quicker motor response due to fuller flux conditions.
4. Faster deceleration to rest, saving valuable products and providing better safety.
5. A flexible consolidated adjustable speed drive with only a-c power available.
6. Actually increased motor horsepower capacity with overvoltage, permitting the same wire to be drawn at higher speed providing cooling permits.
7. Low cost d-c power.
8. Less wire breakage and higher production due to smooth acceleration to higher speeds.
9. Most heavy current capacity contactors eliminated and field current handled instead, reducing control maintenance.

DISCUSSION

PRESENTED BY

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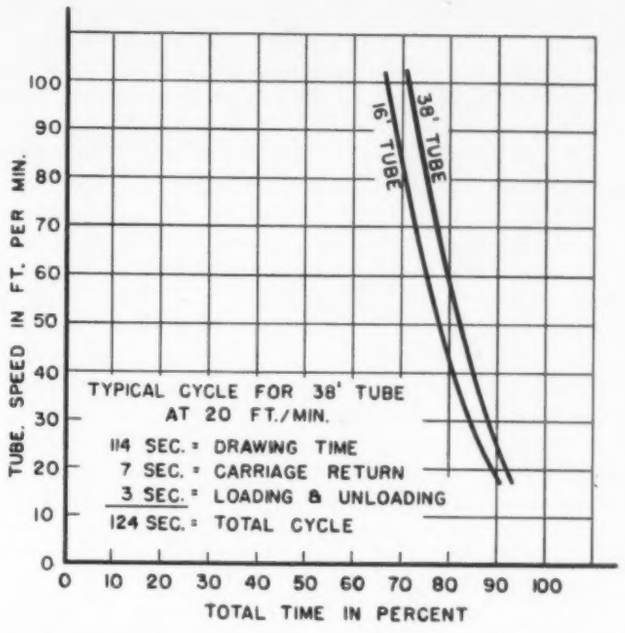
J. R. Erbe: It might be interesting, in discussing this paper, to point out along with the evolution of the draw bench, as Mr. Geuder has shown it to us, how the duty cycle has increased the motor heating. With the old drive of a few years ago, practically the only drive was on the main chain and all of the auxiliary operations were manual — by that I mean the loading and unloading and in some cases even the return of the tongs — in which case the motor was only required to actually draw or operate under its load conditions,



Curve showing drawing time in per cent of total time for draw bench.

about 10 per cent of the total time. The result of this was that no problem existed in having a motor meet its rating as far as the heating was concerned. We recently had occasion to analyze the requirements that have been placed on a motor for the chain drive, on one of the newer, more or less automatic draw benches, in which the auxiliary functions were performed automatically.

The accompanying chart shows a typical duty cycle, and I have analyzed it here on the basis of drawing a tube, about 38 feet long, with a base drawing speed of 20 feet a minute, in which the drawing time was 114 seconds, the carriage return was seven seconds, and it required approximately three seconds for loading and unloading, making a total cycle of 124 seconds.

From the curve, at a speed of 20 feet per minute, you will notice that the motor is loaded 92 per cent of the total time, with the result that any attempt to accelerate the motor and add accelerating and decelerating currents under this condition would have definitely overheated the motor. For comparison, if we draw a 16 ft tube, we find the drawing time here would come down proportionately. The time for the carriage return would stay the same, the loading and unloading time approximately the same. Under these conditions even with the shorter tube we haven't appreciably reduced the duty cycle. We would still have 89 per cent, at the 20 ft per minute speed, in which the motor was actually operating under full load. The result is that under these conditions it becomes more and more necessary that the electrical manufacturers know the full requirements and duty cycle under which a draw bench is to operate in order to give you the best application possible.

E. J. Posselt: I believe Mr. Geuder has given us a very complete picture of different types of draw benches and the application of a-c and d-c motors to that job.

I have a few comments to make which might be considered more as additions than questions. On some d-c draw bench applications it has been found desirable to allow the draw motor to run at "draw" speed after completing the draw to take advantage of the cooling effect at this speed. The draw motor is not slowed down to "hook on" speed until the carriage is slowed down just before reaching the die head. This may allow operation at slightly heavier loads without overheating the motor.

Although most draw benches may be controlled by limit switches for acceleration and deceleration for the "draw" cycle, these functions may be initiated by means of sensitive voltage and load relays on d-c benches. Acceleration to preset "draw" speed may be initiated by a voltage relay connected across the draw motor armature. By using a step of series resistance in the armature circuit of the draw motor for slowdown, its speed torque characteristic may be so altered that its speed will drop sufficiently when normal load is applied to operate the armature voltage relay. A compound relay with its contact in the high speed maintaining control circuit can be set to open when the draw is completed or in case the carriage jaws slip from the work. When this relay opens it initiates the automatic slowdown sequence. The series coil of the load relay is connected in the motor armature circuit and the shunt coil excitation is varied according to the draw motor field rheostat setting, to compensate for normal armature currents at different speeds.

Mr. Geuder stated "It is believed that to date only two-speed accelerating type a-c squirrel-cage motors have been used on draw benches." Several installations have been made since 1940 using four-speed squirrel-cage motors. A-c motors of this type probably are not often used, but they do provide more drawing speeds, smoother acceleration and deceleration which are desired features.

One added advantage which Mr. Geuder did not include for the unbalanced primary control is that this method results in low torque at low speed and high torque at high speed. This approximates the condition obtained on variable voltage d-c drives which provide uniform torque control over the entire speed range.

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JENNINGS *Discussion*

(*Continued from page 46*)

Automatic lubrication versus hand lubrication is quite a subject in itself, but generally speaking, we feel the automatic job is only justified where you need more frequent application than once every three or four hours or once every shift.

W. H. Mandy: Old furnaces with brass bushings and babbitt bearings require more lubricant at frequent intervals. If you have to use larger feeders or measuring valves and install automatic equipment to supply ample lubricant at proper intervals, thereby increasing the cost of the system, would the savings effected warrant the expense of a system? How would such systems compare in cost with those installed on new furnaces?

A. J. Jennings: I think I can say that, generally speaking, on the old furnaces, the very old ones, it would cost somewhat less because there are fewer points. Of course, we all realize that a centralized lubricating system cannot correct some defective mechanical condition or a bearing that is half worn out. You probably would have to put a great deal more grease into a sloppy bushing that is about shot than you would into a reconditioned job and you use a small size valve for a small bearing, and a large size valve or feeder for a larger bearing.

E. J. Ehret: It seems that everybody is pretty much in agreement that centralized lubrication is a good thing for blast furnace tops. In spite of that, I think we can go around the country and find a lot of blast furnace tops being lubricated by hand.

In my experience of some sixteen years in this business, I have found the plant that did the most on centralized lubrication was the plant where some one individual sponsored the project and got behind it and sold the method, sold the management. I have also found the management was willing, if they had enough evidence, to go along with the project.

So it seems that at a time like this, when we need every ounce of production, we should work along the line of getting some of these older blast furnaces equipped.

Production Planning AND Control

. . . . production planning and control seek to answer the what, when, where and how of manufacture, so that products, service and costs will be the best possible . . . .

by L. J. King

CHIEF INDUSTRIAL ENGINEER

CARNEGIE-ILLINOIS STEEL CORPORATION

PITTSBURGH, PENNSYLVANIA

▲ THE importance of production should need no particular emphasis at this time. The importance of production planning is emphasized by the complexity and quantity of products to be produced and particularly in the decentralization of manufacturing to a multitude of sub-contractors, made necessary by the sudden expansion of demand and the urgency of the situation. Without the knowledge and experience of "production engineers" who have been developed in the United States, capable of breaking down the elements involved and planning the manufacture of, say, a four-motored bomber, undoubtedly one of the most complicated mechanisms ever attempted in mass production, or hundreds of other items of equipment for the armed forces, our present war production would be impossible, and we should face certain defeat.

The principles involved in production planning are comparatively simple and easily understood. The application of these principles in a plant like Willow Run, for example, is almost beyond the conception of any one man.

An understanding of the principles, methods and procedures of production planning and control is a positive requirement of every executive carrying responsibility for operations. Surrounding the activities of production are all the problems of commercial relationships, materials, labor and manufacturing expense. These problems cannot be handled in a satisfactory manner unless production is successfully planned and controlled.

Our discussion of production planning and control will be confined to manufacturing operations. This is not because the principles do not apply to other activities, but because our time does not allow a broader discussion. Suffice it to say that in modified forms the principles of production planning and control apply to commercial establishments in the wholesale and retail fields, to the construction industry, to freight movement, to mining, to agriculture and many other activities.

Production planning in manufacturing may be defined as the technique of determining:

What is to be manufactured.
From what it is to be made.
How it is to be made.
Where it is to be made.
When it is to be made.

Production control involves the administration of the plans as made, the release of instructions, and recording the actual progress and comparing it with the plan and, if necessary, revision of the plans.

This seems at first glance to represent almost the complete field of operating management. However, this is not the case.

In a very simple organization, the line supervisor does the planning and control job. This placing of responsibility is quite satisfactory in a very small business, where most of the details of the orders received and in process can be carried in the line supervisor's head. When the organization is composed of many

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inter-related departments, however, and the number of component parts and products is large, the simple system fails under the load of detail, and the responsibility for production planning and control is delegated to a separate department.

The scope of the responsibilities and authorities of the production planning and control department varies widely in different industries and in different companies. In its broadest scope the production planning and control department is responsible for:

1. Long-range planning for months and years ahead.
2. Acquisition of raw materials and control of their quality.
3. Quality specifications both for product and for material in process.
4. Planning for manufacturing facilities, including types and numbers of machines, buildings, etc.
5. Sequence of operations.
6. Delivery promises and customer service.
7. Production and inventory records.

In most well-organized companies today, the responsibility of the production planning and control department is merely advisory in some of these activities. For instance, long-range planning of products and schedules is more clearly a function of sales and top management, aided by whatever forecasting assistance may be necessary.

With the aid of price forecasts, acquisition of raw materials and stores supplies beyond current needs is usually a function of the purchasing and financial departments.

Quality specifications are logically a function of the process control and inspection staffs of the manufacturing and the sales departments.

The planning of manufacturing facilities to execute the long-range plans is a function of the engineering department.

The recording of production and responsibility for maintaining records of inventory is the responsibility of the accounting department.

This leaves as responsibilities of the production planning and control department the sequence of operations (as limited by equipment and facilities), the scheduling of manufacturing operations, making of delivery promises, and follow-up to see that promises are fulfilled or that provision is made in case of failure.

Therefore, in a well-balanced organization, a definition of production planning and control might be: "Within the limits of existing product specifications, raw materials, equipment and facilities, plant layout, manufacturing methods and orders received or increase in inventory as a result of long-range planning, the production planning and control department issues orders to the operating units to process raw materials on specified equipment and facilities to deliver product at a specified place and time and to follow up to determine that these orders are fulfilled." This is a much more specific definition of production planning and control as practiced in the average present-day manufacturing organization.

The emphasis on the various functions of production planning and control and its relative importance in the organization are partially dependent upon the nature of the process. Industry could be divided into four classes by the nature of process as follows:

1. Straight-line process industries having few raw materials and few products or by-products. Examples are the cement industry, flour-milling industry and the paper-making industry.
2. Assembling industries taking many raw materials and making a few similar standardized products. Examples are the airplane industry, automobile industry and industries making complex mechanical equipment in mass production, such as farm machinery, typewriter and radios.
3. Processing industries using a few standardized raw materials and producing a variety of products or products with a variety of treatments. Examples are the lumber and mill-work industry, meat-packing industry and the steel industry.
4. Industries having the most complex features of the second and third classifications, that is, industries starting with a large variety of raw materials and producing a large variety of sizes and treatments of products. An example of this class is an automobile factory in which each car is manufactured to customer's order as to color, tires, special equipment and upholstery. It is interesting to note that the Army has provided some relief from this extreme in the manufacture of war goods by the establishment of modification centers at which special equipment is added for arctic, tropical or other special conditions.

Production planning and control in these types of manufacturing takes many forms as a result of emphasis on different features within the same set of principles. It is this fact that makes any general discussion of the applications of production planning and control almost impossible, because they are shaped into so many forms to meet specific requirements.

We have listed the steel industry in the third classification as a processing industry using a few standardized raw materials and producing a variety of products or products with a variety of treatments.

The steel industry produces steel of hundreds of different analyses in a large number of shapes and products, such as slabs, blooms, bars, structural shapes, rails, strip, tubes, pipe, rods, wire, sheets and tin plate. As an example of the multitude of products produced, the American Steel and Wire Company, a United States Steel Corporation subsidiary, produces over 78,000 wire products alone.

The major raw materials necessary to produce steel are iron ore, coal, limestone and various alloying materials, such as, manganese, chromium, molybdenum, nickel and copper. Such sundry supplies as palm oil, zinc, tin, acids and refractory materials are also used in considerable volume.

The following are some of the fundamental operating factors which must be considered by the production planning and control responsibility in the steel industry:

1. Equipment and facilities represent a large capital investment per dollar of sales, so that maximum effective utilization is paramount.
2. The economic necessity for the conservation of all heat available, since high temperatures are required in making and processing steel.
3. Necessity of accumulating orders of each composition of steel for heat lots, since heat lots of less than furnace capacity are not economical in manufacture or handling.

4. Producing and shipping to customer order item. Contrary to the general public opinion, the steel industry is not a mass-production industry. Producing and shipping of steel is generally by customer order item. Only in the sense of large total volume is the steel industry a mass-production industry.
5. Customer orders involve many analyses of steel, different products, different specifications involving many different processes for many different specific uses.
6. The fundamental necessity of maintaining identification of each heat of steel throughout the process to shipment.
7. The high cost of preparation for manufacture on rolling mills in roll and pass changes. In the case of small lots, the preparatory expense may exceed all other costs and for this reason economical lot sizes become a major problem in scheduling.
8. Necessity of maintaining inventories at a minimum, since the dollar value of inventories of steel, unless closely controlled, reaches intolerable heights.
9. Necessity of long-range planning to assure having an adequate supply of raw materials on hand. This is particularly true in the northern steel companies, where iron ore requirements are shipped over the Great Lakes during the summer months. This supply must last until lake navigation opens in the following spring. Long-range planning is also necessary to permit the mining companies to plan their development programs.
10. Due to the high cost of starting the equipment, as well as the possible damage resulting from shutdown, it is desirable to have a long-range plan of production for coke and pig iron.

In addition to these general operating problems, we have many additional problems arising from the present war conditions, such as the man power shortage, restricted supplies of certain alloying elements and WPB control of products produced and shipped to each claimant agency.

The Carnegie-Illinois Steel Corporation, some time before the beginning of the war, started the development of a complete and comprehensive planning system, primarily involving the sales and operating activities. However, this system has not been completed, due to the war and government control of production resulting in many changes in planning and control systems, but upon return to more nearly normal conditions, the original program will be resumed and completed.

In order to understand production planning and control in the operating department of Carnegie-Illinois Steel Corporation better, a bird's-eye view of the organization will be helpful. The operating department is headed by the vice president in charge of operations. Reporting to him are the staff heads of the following staff divisions: metallurgical, engineering, industrial engineering, raw materials, fuel and power. There are two operating districts, namely, the Pittsburgh district and the Chicago district, each district headed by a manager of operations reporting to the vice-president in charge of operations. The general superintendents of the plants in each district report to their respective manager of operations. At the district level there are comparable staff positions — district metallurgist, district chief engineer, district industrial engineer and manager of raw materials, fuel and power. In each plant are similar staff departments, headed by the plant chief metallurgist, plant chief engineer and plant industrial engineer.

There are three major levels of organization in the operating department, namely, general office, district office and plant. The general office level develops company policies and procedures; the district level administers these policies and procedures throughout the district; and the plants execute the policies and procedures.

The industrial engineering division of the operating department is responsible for the development of production planning and control in the operating department to attain the objectives defined by management.

In the general office, as a part of the industrial engineering division, there is a production planning bureau, headed by a manager, who reports to the chief industrial engineer. It is the responsibility of the manager, production planning bureau, to:

1. Recommend policies and develop the principles for the execution of the production planning program.
2. Define clearly the form and responsibility of organizations in the operating department concerned with planning and controlling production.
3. Develop and maintain standard procedures for executing the program in the various plants in a uniform manner.
4. Represent the operating department in inter-departmental relationships involving production planning.
5. As representative of the operating department, collaborate with the director of priorities in the development of general procedures for the corporation to comply with priority rules and regulations.
6. Place in execution those general procedures that affect the operating department by preparing and issuing standard procedures that describe in detail how the priority rules and regulations are to be met.
7. Serve in an advisory capacity to the general, district and plant managements in regard to matters relating to production planning.
8. Check district and plant industrial engineering divisions for adherence to policies, principles and standard procedures.

The objectives of the bureau are:

1. To improve customer service.
2. To reduce operating costs by the efficient scheduling of production.
3. To develop uniform production planning procedures for the various plants for the purpose of utilizing best methods throughout the operating department and to facilitate management control of production.

The statement of policy on production planning says:

1. Production planning in the operating department shall be treated as a staff function of the operating department management and shall be performed by separate units of organization whose responsibilities shall be clearly defined.
2. The production planning program shall be based on a careful analysis of operating methods, materials, etc., and upon accurate time standards.
3. Uniform procedures shall be developed for use throughout the operating department and shall be expressed in writing.

4. Uniform production planning methods shall be established throughout the operating department as a means for effective control of production by management.

The district industrial engineer, through the assistant to the district industrial engineer (production planning) and his organization, is responsible for the coordination of the development programs in the plants of the district and for assisting the plants in the execution of the program.

The plant industrial engineer, through the assistant to the plant industrial engineer (production planning) and his organization, is responsible for development and installation of the system within the policies and procedures of the company.

The actual production planning and control functions are performed in the production planning department, headed by a superintendent of production planning, reporting to the general superintendent of the plant. The production planning department looks to the industrial engineering division for staff help in the development of its organization, system and methods of operation. The functions of the production planning department are:

Order entry —

A. Receive, log and file customer orders and all information pertaining thereto.
B. Clear order details — credit, packing, traffic, errors.
C. Prepare manufacturing order.
D. Publish control reports.
E. General departmental stenographic and duplicating work.

Scheduling and promising —

A. Allocate items to producing units.
B. Backlog orders by unit and/or process.
C. Develop and issue delivery promises.
D. Arrange for procurement of raw materials.
E. Plan blast furnace operations and distribution of hot and cold metal.
F. Schedule mould and stool foundry operations.
G. Develop semi-finished steel requirements.
H. Build semi-finished steel orders into heats.
I. Develop steel production schedules (including mould yard operation).
J. Distribute steel production to primary rolling mills.
K. Develop schedules for primary mills, conditioning yards, finishing mills and processing units.

Inventory control —

A. Maintain complete records of production material.
B. Apply all inventory material against orders.
C. Control quantities for sizes and grades carried in inventory.
D. Issue necessary orders for the production of inventory material.

Order service —

A. Act as contact point for the sales department and other plants on matters dealing with order service, etc.
B. Maintain promise performance by verification of mill adherence to planned schedules.
C. Maintain one complete, accurate and current record of order progress for scheduled orders so as to reflect scheduling, rolling status, finishing status, shipping commitments and shipments made.
D. Plan shipment of material.
E. Execute combination and less-car-load shipments for all inter-, intra- and extra-plant destinations.

Upon receipt of the customer's order at the plant, product specifications are assigned and process of manufacture determined. Working from the shipping date, each process is scheduled in sequence to the actual making of the steel in the electric furnace, open hearth or bessemer converter. Orders are issued so that if each process is completed as scheduled, the promised shipping date is met. This appears comparatively simple when reduced to these terms. However, we should keep in mind some of the general operating problems heretofore outlined.

Let us assume we have developed a schedule for each operation and process involved in producing and shipping a customer's order item and that in making the required heat of steel in an open hearth furnace, for some reason it does not meet the required specification. This does happen occasionally, even in this enlightened day, for the making of open hearth steel is still not an exact science. The result is a problem for the production planning department. It has a heat of hot steel, maybe 200 tons, on its hands which must be economically disposed of within a matter of one or two hours. An endeavor is first made to apply the steel to suitable orders on hand, and this can often be done under the present order situation, although it may necessitate revisions of many schedules. A heat of steel so handled is termed a diverted heat. If, however, the heat is of special analysis, probably containing alloying elements, decision must be promptly made whether to scrap the heat or to schedule the rolling into a semi-finished size that may be ordered in the future.

The effect of an off-analysis heat upon mill schedules may be readily imagined. Orders not scheduled for several weeks may be moved up and scheduled to use the steel, perhaps on different mills from that originally planned, and the lost heat must be re-scheduled in time to meet the promised shipping dates. For these reasons and others inherent in the manufacture of steel, the planning and control of production must go on twenty-four hours per day.

Up to this point we have discussed the problems and some of the methods used under normal conditions. With the beginning of the defense program in the spring of 1941, regulation has followed regulation, through priorities, production directives and the controlled materials plan. The development of our production planning organization and methods has been slowed down or halted by the necessity of assigning more and more of the key personnel to the interpretation of government regulations and preparation of procedures for execution of these regulations in the plants; nevertheless, in the meantime we are gaining in knowledge every day through experience developed under extreme pressure for maximum production of steel.

Our objectives in the operating department for production planning and control under normal conditions are:

1. To plan what will be manufactured.
2. When it will be made.
3. On what equipment and facilities.
4. By what process,

so that the products, customer service and costs of manufacture will be the best possible.

DISCUSSION

PRESENTED BY

J. HALFPENNY, Chief Industrial Engineer, Tennessee Coal, Iron and Railroad Company, Birmingham, Alabama

J. B. COPPER, Supervisor, Cost Accounting, Industrial Engineering Department, Tennessee Coal, Iron and Railroad Company, Birmingham, Alabama

L. J. KING, Chief Industrial Engineer, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania

J. A. SMITH, Assistant Shop Superintendent, Tennessee Coal, Iron and Railroad Company, Fairfield, Alabama

T. W. BOONE, Supervisor, Cost Standards, Industrial Engineering Department, Tennessee Coal, Iron and Railroad Company, Birmingham, Alabama

J. Halfpenny: I would like to ask the speaker to clarify his meaning when he referred to "exact standards." Does he mean standards upon which we could properly pay incentive plans?

L. J. King: There is only one "standard" and that is an engineered standard, which would be used for production planning and scheduling, for determining capacities of equipment, for standard costs, if you please, and for wage incentive purposes. They should be all one and the same. This may be a little theoretical, but actually that is what it should be.

J. B. Copper: I would like to ask Mr. King, in connection with cost planning, which I think is a closely allied subject, his opinion as to how cost planning data is used in connection with production control by the production engineer. Are certain considerations given to the cost of orders, and whether or not special orders require special costs in connection with hot metal distribution, and things of that nature.

L. J. King: A lot of things that we do today have been developed over a good many years. As quickly as possible we study each problem on the basis of the economics of the situation.

J. A. Smith: What success, Mr. King, do you have, with this direct routing from the sales order to the mill?

L. J. King: Previous to the development that I mentioned on production planning and control in the operating department, orders went through an order department in the general office and in turn this department scheduled the mills. It was very evident that this was an intermediate and unnecessary step. So, within the scope of the policies and the procedures laid down by the general office, the district sales offices today, no matter where they are, immediately transmit the order to the plant that is going to produce and ship the material.

This has simplified the problem of service to the district sales office and to the customer ultimately to the point where today we speak in terms of days.

J. Halfpenny: I would like the speaker to elaborate a little on the question of production control. In these United States I find control is very difficult. Everybody wants to do as he pleases. So far as I am concerned, I have found that explanation and education are helpful somewhat, but I would like to have the speaker give us what in his experience is the best method of control.

L. J. King: In production planning and control, your plan of production and schedule, which is developed by your production planning department, starts from the date the material is to be shipped from the plant. You build back finally until you get to your ingots or hot steel to be made in the steel producing unit.

One of the things that came out of CMP, for which I think the steel industry some day will be very thankful to WPB, is that their production directives are shipping rather than rolling directives. To those that are familiar with steel mills, you realize that is rather a revolutionary statement to make, because always in the past it has been the practice to schedule rollings, knowing that eventually the material will be shipped out of the plant.

Today, with all of the processing that has to be done, heat treating, annealing, conditioning, and so forth, every one of those processes or operations must be scheduled, and not just the rolling, because very often we find that those requirements are bottle-necks, rather than the steel mill itself, in the matter of production. So I say some day the steel industry may thank WPB that they do make their directives shipping rather than a rolling or production directive.

Having made such a plan and schedule, starting from the shipping date, in our organization the production planning department issues the orders to the subsequent operations so as to meet that shipping date.

We must control the adherence to the schedule by having reports made currently on how well the schedule is being maintained from the open hearth clear through to the loading on the cars. Operators prefer to have a certain degree of latitude in adhering to the schedules as set up by the production planning department. It is our conception that the production planning and control department will know more about the problems, and what the situation is, through their intimate contact with the sales department; that they must follow each order item from the time it is received into the plant as an order until it is shipped.

J. A. Smith: The business of diverted blast furnace casts, open hearth heats, etc., is an old one. The further problem of changing mills for light tonnages is another old one. During times like these, with large backlogs, and where one must place an order six or seven or eight months in advance to get it rolled, the operator has sufficient time to make his plans. I would like to know, however, during what we have known as "normal times," how flexible your order entry seems to be.

L. J. King: In connection with this, if I may lead up to the answer, it is true that we have orders on our books months and months in advance. But in Carnegie-Illinois Steel Corporation, we endeavor to advise our customer within ten days upon receipt of an order the

(*Please turn to page 78*)

Speed Control AND Braking FOR A-c CRANES

. . . . unbalanced primary voltages as applied in this control gives suitable, safe, stable lowering speeds for a-c hoists over a wide load range . . . .

by E. J. Posselt

ASSISTANT SUPERVISING ENGINEER

CUTLER-HAMMER, INC.

MILWAUKEE. WISCONSIN

▲ WE are all interested in new methods, devices, machines, etc., therefore whenever a new control device or scheme is announced we are anxious to find out what it is, where it applies, how it functions and how it compares with other schemes or methods. If we have the answers to these questions it places us in a better position to apply it properly and benefit by the improved results made possible by the new method.

The subject of speed control and braking for a-c cranes will be discussed by reviewing some of the various methods employed in the past before explaining a new method for controlling the speed of standard wound rotor three-phase motors. The scope of the paper does not include all the theory and mathematics which might be used to describe the evolution of the scheme since its object is to explain what the scheme is, how it functions and something about its limitations.

The application of a-c motors on crane hoists in the past has been limited to relatively few installations partly because the many methods employed for controlling the speed of an overhauling load have not been satisfactory for general purposes. On small hoists using squirrel cage motors with across the line control, speed control usually is not a problem since the lowering speeds can be easily regulated by mechanical devices. The scheme discussed in this paper was developed for the larger hoists using slip ring motors to provide speed regulation in both directions of operation.

Hoist gearing designed to prevent overhauling may be satisfactory on some installations such as power house cranes. This is usually limited to slow cranes where frequent operation is not encountered. The conventional reversing type of controller is satisfactory under these conditions.

Mechanical load brakes may be used. They are designed so that a braking torque will be applied in the lowering direction but not in the hoisting direction. The motor therefore drives a positive load for either direction of operation. Speed control in the lowering direction is obtained by regulating the driving torque of the motor. The service on this type of brake is severe with the result that it is not always in best operating condition and maintenance costs are appreciable.

A modified form of mechanical loading brake incorporating automatic control of the braking torque is sometimes used. In this scheme a motor driven hydraulically operated brake is connected so that it will be energized from the secondary of the slip ring motor in the lowering direction. The torque developed by the brake depends upon the speed of an impeller driven by the brake motor. With the hoist motor at

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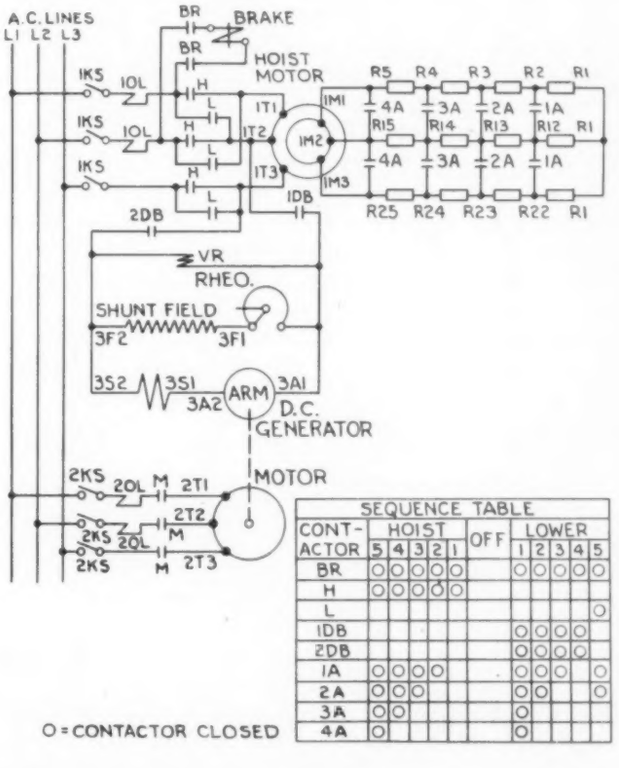
standstill or at 100 per cent slip the rotor frequency is the same as the stator or line frequency. As the hoist motor accelerates the rotor frequency decreases and at 100 per cent speed or zero slip the rotor frequency will be zero. Since the brake motor is connected to the hoist motor rotor its speed will be governed by the frequency of the rotor circuit. Therefore the brake will provide minimum braking torque when the hoist motor is at standstill and increase as the lowering speed increases until maximum braking torque is reached at 100 per cent lowering speed. The net torque for driving an empty hook or retarding an overloading load is the difference between the retarding torque of the electro-hydraulically operated brake and the driving torque of the hoist motor. By automatically transferring the brake motor to the main lines so the brake will be released on the higher speed operating points of the master or drum switch, high speed lowering is obtained. As the brake lining wears or due to accumulation of dirt, grease, etc., the characteristics of the hoist will change. Because of the inherent time delay in releasing and setting of this type of brake, inching operations may be unsatisfactory.

Regenerative braking is another method, limited to relatively few installations on which slow lowering speeds are not essential. The speed is regulated by commutating the motor secondary resistor and cannot be made less than synchronous speed. With the motor secondary short-circuited minimum speed is obtained and this will be above synchronous speed by an amount determined by the slip of the motor for the load being lowered. Speed regulation is poor with the result that if the resistor stepping is designed to give the desired speed changes for full load conditions the speed changes are much less with light load. With no load the speeds would practically be the same on all lowering points of the master.

By short circuiting one pair of the motor primary or stator terminals and applying single phase to the remaining circuit, regulation below synchronous speed can be obtained with overhauling loads. This feature is sometimes used in addition to the regenerative braking method just described in order to obtain regulation below synchronous speed.

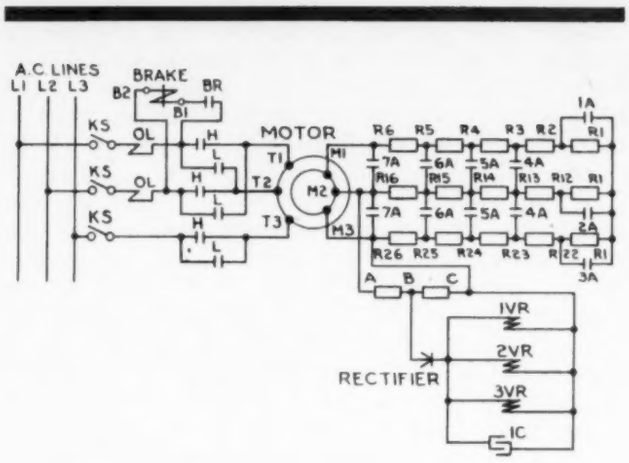
Direct current braking provides a greater range of speed control than regenerative braking as it functions either above or below synchronous speed. It also has limitations because an overhauling load is required in order to lower. Therefore in order to drive down an empty hook the scheme should incorporate a kickoff or power circuit on the last speed point in the lowering direction. A separate d-c line, or a motor generator set, is required to supply the direct current to one phase of the hoist motor during the lowering operation. A typical circuit is shown in the schematic diagram Figure 1. Contactor M which may be push button operated is closed to start the motor generator set when setting up the equipment for operation. The hoist motor control is interlocked by the VR relay to prevent operating the hoist unless d-c power for braking is available. The sequence table indicates the contactor operation for the various master switch positions. The holding brake is released on all operating positions by the closing of relay BR. In the hoisting direction the line contactor H and the secondary accelerating contactors are operated in the conventional sequence as the master switch is moved from the off position to the 5th point hoisting. On the 1st point lowering contactors 1DB and 2DB are closed to connect d-c to one phase of the hoist motor primary circuit and at the same time all accelerating contactors 1A, 2A, 3A, and 4A are closed. Maximum retarding torque is obtained under these conditions. As the master switch is moved to succeeding points accelerating contactors are opened in the reverse sequence to insert resistance in the hoist motor secondary circuit. The retarding torque is decreased as resistance is added to the secondary circuit thereby allowing the speed to increase on an overhauling load. On the 5th point lowering d-c is removed from the motor primary, and the L contactor closes to connect the motor to the line to drive the hoist in the lowering direction. Accelerators 1A and 2A are closed at the same time to limit the speed. A light hook may be driven down on this point and a heavy load will be retarded by regenerative braking. With an assumed overall efficiency of 80 per cent for the hoist, the torque required at the motor for lowering a full load on the hook will be equal to full load motor torque multiplied by the square of the efficiency. Therefore the required motor torque is 64 per cent of full load torque to hold full load on the hook. If the resistors are designed to provide a full load lowering speed of 150 per cent of the full load hoisting speed on the 4th speed point lowering this speed would be reduced to approximately 80 per cent speed at 35 per cent torque on the motor shaft. This is an appreciable change in speed for the change

Figure 1 — Schematic diagram of a-c hoist controller with d-c braking in lowering direction.



in torque indicated. It is desirable to have a narrower differential between light load and full load speeds. On slow speed points, however, the slope of the speed-torque characteristics is changed so this differential is improved. The d-c generator must provide a voltage which will produce about full load current through the hoist motor primary winding. Since this will be a low voltage a special d-c generator is necessary, which will add to the cost of this unit although its capacity may only have to be about 1/20 of the kw rating of the hoist motor. If d-c shop lines are used instead of the special generator it will be necessary to use a series resistor for adjusting the hoist motor current.

Counter torque lowering is a method devised to provide speed control below synchronous speed, but since it also is a method for controlling overhauling loads only, provisions are necessary similar to the direct current braking scheme to drive down an empty hook. Figure 2 shows a counter torque lowering scheme with the last point in the lowering direction connected to drive an empty hook down at synchronous speed. It should be noted contactors 1A, 2A and 3A are three single pole contactors, instead of the usual single two pole contactor. The sequence table indicates the position of each contactor depending on the master switch position, and as modified by the operation of the voltage relays. With the motor at standstill, and the master switch in the off position, all contactors are open and the brake is set. On the first position hoisting, contactors BR-M-H-1A-2A and 3A will close immediately, which will release the brake, and give reduced torque to take up slack in the cable. Moving the master switch to succeeding points will close the accelerating contactors 4A to 7A in sequence, increasing the torque and speed. Returning the master switch to the off position will open all contactors and set the brake to stop the motor. Moving the master switch in the lowering direction does not release the brake, or apply power to the motor, until the last point is reached. Contactors BR-M-L and 4A will close immediately, and be followed by the closing of 5A-6A and 7A timed in sequence by the automatic timing method being employed. This will release the brake, and apply power to drive the motor down at synchronous speed. When the master switch is returned to the 4th position the lowering contactor L will be opened, and the hoisting contactor H will be closed. At the same time all accelerating contactors will be opened. This will result in a relatively weak hoisting torque to act as a brake and slow down an overhauling load. On the 3rd point contactor 1A will be closed to increase the braking torque. On the 2nd point 2A will be closed and on the 1st point 3A will be closed, each step further increasing the braking torque. D-c voltage relays 1VR-2VR and 3VR operate through a rectifier connected to the motor secondary through a voltage adjusting resistor; 2VR and 3VR are set to close in case the speed becomes too high; 2VR is set to close first and will close 1A on the 4th point (except for this relay, 1A would not be closed by the master switch); 3VR will close next to close 2A on both the 4th or 3rd points of the master switch. When the master switch is returned to the off position, the brake will be set by the opening of BR, but all other contactors which were closed on the 1st point will be maintained by 1VR until the motor has practically stopped. With this arrangement counter torque power is maintained to help the brake stop the motor. The torque with 3A closed is sufficient to insure that under any load conditions the motor will be brought to rest and therefore the wear on the brake and the stopping time are reduced. The speed torque characteristics obtained by this method are not quite as good as those obtained with the direct current braking method previously described, but for practical purposes may be considered about the same. On the basis that about the same results can be accomplished with less material, counter-torque lowering is usually preferred over the direct current braking scheme. One undesirable feature of the counter torque scheme, however, is the fact that a light load may raise, instead of being lowered, if the operator is not careful in manipulating the master switch to match the load being handled. Devices may be added to prevent reversed rotation, but operation may be rather difficult because when the motor is stopped by these devices the master switch must be returned to the power lowering point to restart and continue the trip.



SEQUENCE TABLE											
CONT-ACTOR	HOIST					OFF	LOWER				
	5	4	3	2	1		1	2	3	4	5
BR	○	○	○	○	○		⊖	⊖	⊖	⊖	○
M	○	○	○	○	○	●	○	○	○	○	○
H	○	○	○	○	○	●	⊖	⊖	⊖	⊖	
L											○
1A	○	○	○	○	○	●	⊖	⊖	⊖	◑	
2A	○	○	○	○	○	●	⊖	⊖	◒	◒	
3A	○	○	○	○	○	●	⊖				
4A	○	○	○	○							○
5A	○	○	○								○
6A	○	○									○
7A	○										○

○ = CONTACT CLOSED.
⊖ = CLOSED IN RETURN DIRECTION OF MASTER AFTER L IS CLOSED ON 5TH POINT.
◑ = CLOSED BY 2VR IF SPEED IS ABOVE PRESET VALUE.
◒ = CLOSED BY 3VR IF SPEED IS ABOVE MAXIMUM PRESET VALUE.
● = MAINTAINED BY 1VR IN OFF POSITION UNTIL MOTOR STOPS.

Figure 2 — Schematic diagram of a-c counter-torque lowering hoist controller.

Many of the objectional features of a-c hoist controllers may be overcome by a new method of speed control and braking for a-c motors which is adaptable to both positive and negative loads. Most of the previous discussion has been relative to lowering overhauling loads, because on a-c cranes in the past the performance obtainable for this part of the operation has not been as good as desired. The speed-torque characteristics of the conventional secondary resistor

controller in general have been satisfactory for hoisting. By an arrangement applying an unbalanced three phase voltage to the primary of a slip ring motor, combined with a given amount of external resistance in its secondary circuit, improved speed torque characteristics for lowering loads are possible. A controller incorporating this method for regulating the hoisting and lowering operations of a crane will satisfy most general applications.

If two identical wound rotor induction motors having a common shaft are connected to two separate alternating current systems of opposite phase rotation so that the voltages on each motor can be varied separately, the motor torques will oppose each other.

Characteristic speed torque curves LT and HT shown on Figure 3 may represent the curves for these two wound rotor motors of opposite phase rotation. It should be noted, however, that these two speed torque curves are representative of motors with a given secondary resistance and magnitude of applied voltage for each. If the secondary resistance or the magnitude of applied voltage of either motor is altered, its corresponding speed torque curve, and hence the resultant speed torque curve NT of the shaft, will be altered.

Since the two motor torques oppose each other and either may be made the stronger, the net result is that the shaft speed-torque curve may be in a direction tending to either hoist or lower the load. When the difference between these two opposing torques becomes equal to the load torque, the motors will run at a speed corresponding to that particular load.

The new control to be described sets up a condition by which these opposing torques are developed within a single motor instead of in two separate identical motors as just described. The unbalanced voltage system is essentially equivalent to two balanced voltage systems of the same frequency, but with different amplitudes and rotating in opposite directions. The two magnetic fields rotating in opposite directions will develop two opposing torques similar to those of the two identical motors. The resultant torque on the motor shaft can therefore be changed as desired by varying the unbalanced voltage.

One method of obtaining the unbalanced voltage is to use an auto-transformer connected between two of the phases of the balanced three phase system. By the use of an overhanging winding and taps on the transformer, the motor voltages may be varied. Then by adjusting the motor secondary resistors it is possible to obtain the type of speed torque characteristic desired.

Figure 4 shows how the motor primary and the auto-transformer may be connected to the a-c lines to obtain the required unbalancing for lowering operations. The vector diagrams indicate the voltage relationships and phase rotation for each lowering point on the master switch. Three phase a-c supply is connected to L1-L2-L3; L1 is connected direct to motor terminal T1 while L2 is connected to transformer tap 8; L3 is connected to one end of the transformer marked tap 1. Motor terminal T3 is connected to tap 4. All the foregoing connections remain the same for any lowering position on the master switch. Motor terminal T2 only

Figure 3 — Diagrammatic sketch for two a-c motors on a common shaft with opposite phase rotation.

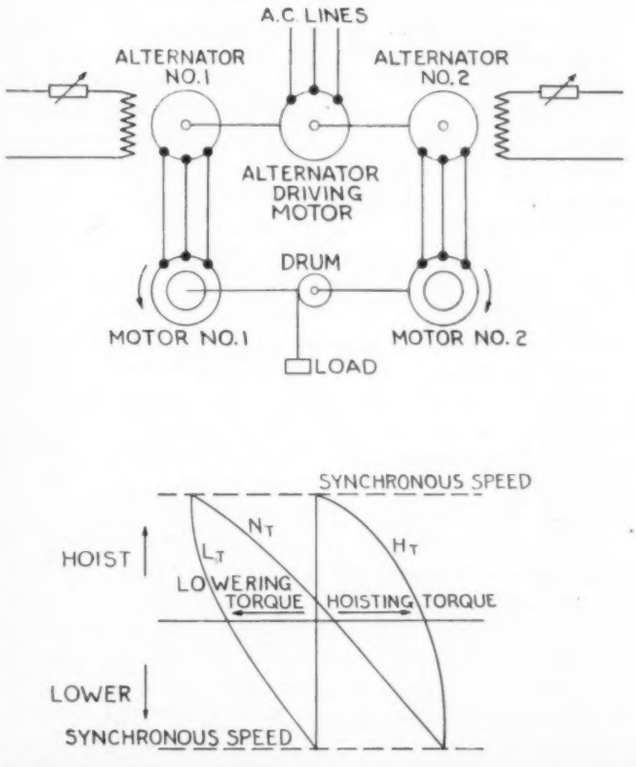
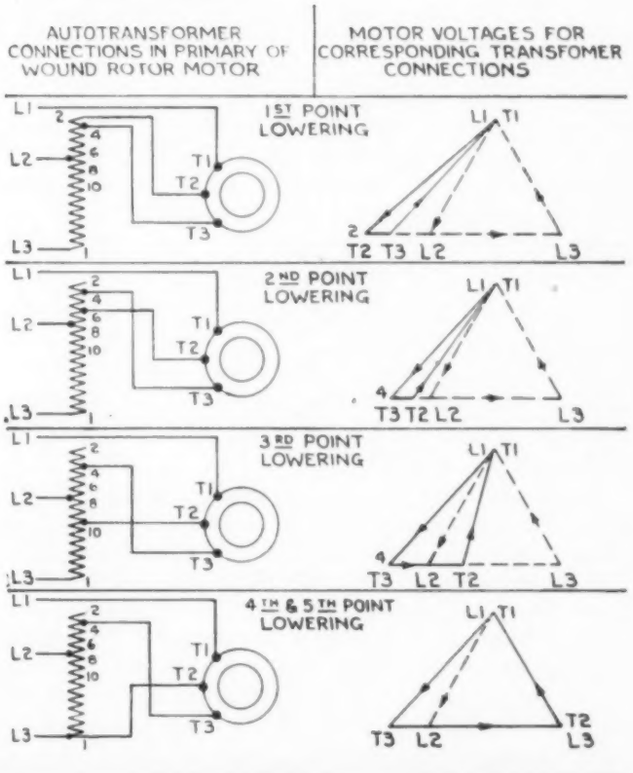


Figure 4 — Vector diagram for a-c motor with unbalanced primary voltages.



is reconnected to different taps on the transformer when moving the master switch from one lowering point to another. Transformer section 2 to 8 is referred to as the overhanging winding. Voltage produced by the overhanging winding will be proportional to the turn ratio of the transformer, and in phase with the impressed voltage on section 1 to 8. For the first point lowering the voltage across the overhanging winding of the transformer is represented by vector T2-L2, and is in phase with the line voltage L2-L3. The voltage across the full winding of the transformer is the sum of these two vectors and is represented by the vector T2-L3.

Line phase rotation is assumed to be counter clockwise in the sequence L1-L2-L3. It is also assumed that motor torque will be in the hoisting direction if the motor phase rotation is counter clockwise, that is, if L1-L2-L3 are connected to T1-T2-T3, respectively.

Referring to the first point lowering on Figure 4, T2 is connected to tap 2 and T3 to tap 4. This provides a low voltage across terminals T2 to T3. The value of this voltage is plotted vectorially to the left of L2-L3, and in an amount determined by the transformer winding. The phase rotation of the motor applied voltage is counter clockwise as shown, which on the basis of the foregoing assumptions produces torque in the hoisting direction. Although a hoisting torque is developed its magnitude is not sufficiently high to overcome the friction and load of the empty hook and start the motor in the hoisting direction. By selecting the proper value of resistance for the motor secondary circuit a stalled torque of 10 per cent full load torque may be obtained. This point provides a minimum lowering speed for average loads.

On the second point lowering, Figure 4, T2 is shown connected to tap 6, which results in higher voltage being impressed across terminals T3 to T2. Completing this vector diagram results in relative voltages across the other motor terminals as shown. Note that T2 is now located between T3 and L2, which reverses the motor phase rotation to make it clockwise. Torque is now produced in the lowering direction. With the secondary resistor the same as on the first point, this provides sufficient torque for lowering the empty hook at slow speed. About 20 per cent of full load hoisting speed may be provided at zero torque.

Moving to the third point lowering will change the T2 motor terminal to tap 10 increasing the impressed voltage across terminals T3 to T2. The completed vector diagram shows the other phase voltages. Without changing the secondary resistors, the lowering torque is increased to provide about 100 per cent speed with full load on the hook.

Fourth and fifth lowering points on the master switch provide the same primary connection. Motor terminal T2 is connected to tap 1, which is the same as L3. With this connection more than 100 per cent line voltage is impressed across terminals T3 to T2. The vector diagram shows the other phase voltages. On the fourth point the secondary resistors are the same as the preceeding three points, and a full load speed of 120 per cent may be obtained. When the master switch is moved to the fifth point additional resistance is inserted in the secondary circuit, increasing the full load lowering speed to about 150 per cent of the full load hoisting speed.

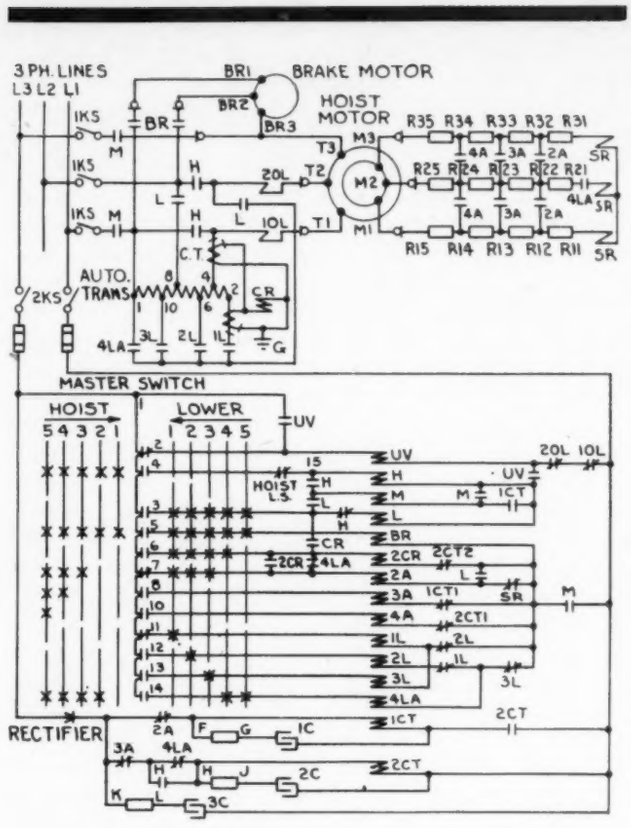


Figure 5 — Line diagram for a-c dynamic lowering hoist controller.

Figure 5 shows a complete control scheme for an a-c dynamic lowering hoist controller, using an auto-transformer as described in the foregoing to provide the unbalanced voltages for the motor primary winding. It also indicates how the various operating sequences are obtained, and the method used for obtaining dynamic braking in the off position of the master switch. D-c for the condenser timing relays is provided by a selenium half wave rectifier. All the standard protective features are included. Five regulating speed points are shown for each direction of operation. In checking the operating sequence it will be seen that the hoisting sequence is essentially the same as that of the conventional secondary resistor type of controller. The lowering sequence is new as it sets up the primary circuits for the proper unbalance voltages in combination with resistors in the secondary circuit to provide a different speed torque characteristic for each operating point of the master switch.

Point by point operation is as follows:

Off position — Undervoltage relay UV is energized to establish a circuit for the main line contactors, and to set up its maintaining circuit. Condenser timing relays 2CT and 1CT will be energized in sequence. All the condensers 1C, 2C and 3C will be charged through their respective current limiting resistors; 3C is a smoothing condenser used to iron out the rectified a-c passing through the half wave rectifier. A normally open contact on 1CT prevents starting until 1CT

closes. The closing of this 1CT contact also signifies that the circuits for 2CR, 3A and 4A are opened by the timing relays.

Hoisting — Point 1. Contactors H, M and BR will be energized in sequence to connect the motor primary direct to the line and release the brake. This applies full and balance three phase voltage to the primary of the motor. Since 4LA is not energized, one phase of the secondary will be open circuited and the other two phases will be connected with all resistance in circuit. With suitable resistor values this connection will provide a stalled torque of 50 per cent of rated full load torque for slack cable take-up.

Point 2. Contactor 4LA will be energized to connect the resistor in the third phase of the secondary. This balanced three phase secondary resistor is selected to give a locked rotor torque of 100 per cent of full load torque. If the load is not too great hoisting will start on this point.

Point 3. Under starting conditions contactor 2A will be energized immediately, because the series relay contact SR will not have been opened. SR opens only when the motor is plugged. Closing the 2A contacts in the rotor circuit will by-pass a portion of the secondary resistor in each phase, to increase the stalled torque to 200 per cent of full load torque. It also by-passes the series relay coils SR, to make the relay inoperative to the succeeding inrushes. Opening the 2A interlock contact in the 1CT timing relay circuit initiates the discharging of condenser 1C through the FG resistor and 1CT coil. After a predetermined time interval, contact 1CT1 on relay 1CT will close to establish a circuit for the succeeding accelerator 3A, under the control of the master switch. The 1CT contact in the M coil circuit will also open during this time. The timing of contact 1CT1 is adjustable, but contact 1CT is non-adjustable.

If the timing of relay 1CT is completed, contactor 3A will be energized to further reduce the rotor circuit resistance, and so further increase the motor torque and speed. When 3A operates it also opens a circuit to timing relay 2CT, initiating the discharging of condenser 2C through the HJ resistor and 2CT coil. This relay is the same as 1CT, although both adjustable contacts 2CT1 and 2CT2 are employed on 2CT. One contact on 2CT is used to provide time when hoisting and the other contact is used to provide time when lowering. The circuit for the 4A coil will be closed by 2CT1 when hoisting and the 2CR coil circuit will be closed by 2CT2 when lowering.

Point 5. If the timing of relay 2CT is completed, contactor 4A will be energized to bring the motor up to practically full speed at rated load. A small amount of slip resistance still remains in the rotor circuit. In order to equalize the accelerating inrushes it is necessary to provide some resistance in the rotor circuit when 4A closes. The value required is relatively small and it is more economical to retain it as a slip resistor than add the necessary material to the controller for cutting it out of circuit.

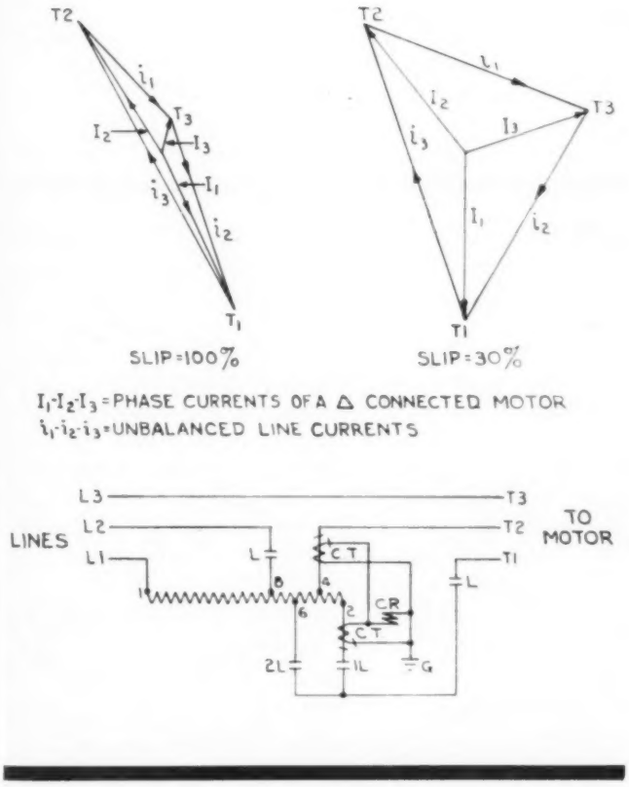
Lowering — Point 1. Contactors L and M will be energized in sequence and be followed by BR, 2A and 1L being energized simultaneously. This completes the circuit to the motor primary through tap No. 2 of the auto transformer, providing the unbalanced voltage indicated for this operating point on Figure 4. The closing of 2A establishes a balanced secondary resistance having a value which, in combination with the unbalanced primary voltage, will result in a stalled torque of 10 per cent full load torque. As previously stated, the motor torque is in the hoisting direction but of insufficient magnitude to actually cause an empty hook to be raised.

Point 2. After contactor 1L is deenergized, 2L will be energized through the normally closed interlock on 1L. All other connections remain the same as for point 1. This transfers motor terminal T2 from tap No. 2 to tap No. 6, which is on the other side of the transformer tap to which T3 is connected. In addition to changing the motor phase voltages, this transfer also reverses the motor phase rotation, so that the motor torque will now be in the lowering direction. At zero motor torque about 20 per cent speed will be obtained, and sufficient torque will be produced to lower an empty hook at slow speed.

Point 3. Contactor 2L is deenergized, after which 3L will be energized through the normally closed interlock on 2L. All other connections remain the same as for point 2. Terminal T2 is thereby transferred from tap No. 6 to tap No. 10, further increasing the voltage across motor terminals T3-T2, as is shown on Figure 4. This increase of voltage which corresponds to a decrease of voltage unbalancing in the motor primary, results in a higher speed and will produce about 100 per cent rated speed with full load on the hook.

Point 4. As previously mentioned in the discussion of the auto-transformer connections shown in Figure 4, the motor primary and auto-transformer connections

Figure 6 — Current relay circuit and vector diagrams for unbalanced voltage system.



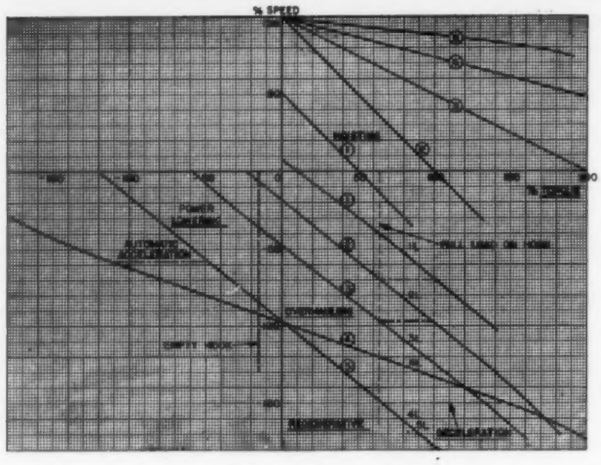


Figure 7 — Speed-torque characteristics for a-c hoist controller with unbalanced primary voltages for lowering.

are the same for both the 4th and 5th points lowering. Higher speeds are obtained on the 5th point by increasing the value of resistance in the rotor circuit. This method results in the slope of the speed torque curve on the 4th point being less than that for either the 3rd or 5th point. Because of these characteristics, when operating with an empty hook, the change in torque will be less by transferring from the 3rd to the 5th, and then to the 4th speed point, rather than direct from the 3rd to the 4th point. This preferred sequence of events to obtain more equal changes of torque is obtained automatically when the master switch is moved from the 3rd to the 4th point.

Moving the master switch from the 3rd to 4th point will deenergize 2A and 3L together; 4LA will then be energized. Terminal T2 is thus transferred from tap No. 10 to tap No. 1 and additional balanced three phase resistance is inserted in the rotor circuit. These connections are the same as finally obtained on the 5th point, however they are only retained for a predetermined period depending upon the timing of relay 2CT. When 4LA operates it initiates the timing of relay 2CT, which will energize relay 2CR when contact 2CT2 closes. This results in contact 2CR closing to reenergize contactor 2A, thereby reducing the resistance in the rotor circuit to the same value provided on all the previous lowering points. About 120 per cent rated speed will be obtained on this point with full load on the hook.

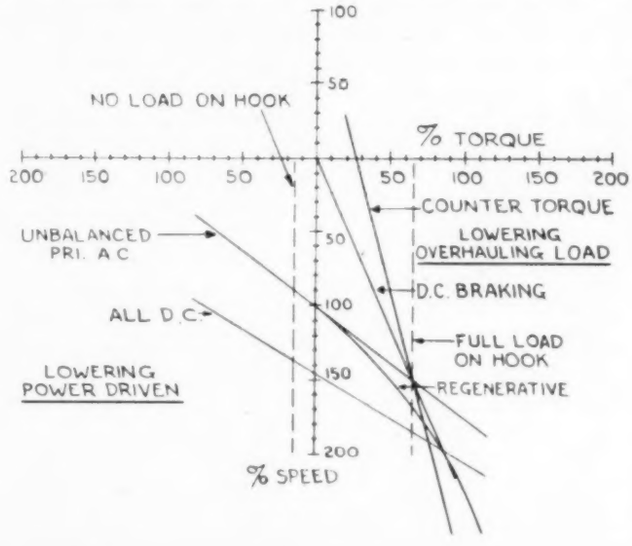
Point 5. As already stated this point is the same as point 4, with the exception that additional resistance is inserted in the rotor circuit. This is accomplished by deenergizing 2A and 2CR simultaneously from the master switch. With full load on the hook about 150 per cent rated speed is provided on this point.

Deceleration — Returning the master switch to the 4th point will energize 2CR immediately, since 2CT2 is now closed; 2A will be energized as soon as 2CR closes. The circuit will at once be reconnected to that finally provided on the 4th point lowering, and the speed will be reduced accordingly. Moving the master switch back to the 3rd point will cause 3L to be energized, and 4LA to be deenergized. This results in the motor being reconnected the same as it was on the 3rd point lowering. The dropping of 4LA also closes the circuit to 2CT and condenser 2C, to recharge for another timing cycle. As the master switch is returned to the 2nd and 1st points. 3L-2L and 1L are operated in succession to provide the same motor connections as before on these same points, and to reduce the motor speed in successive steps. When the master switch is returned to the off position all equipment will be deenergized excepting UV, 1CT, 2CT, 1C, 2C, and 3C unless the motor speed has not decreased sufficiently to allow the CR relay contact to be opened.

Relay CR functions in the off position of the master switch to retain the motor connections provided on the 1st point until the motor has almost stopped. The method of accomplishing this operation of the CR relay will be described later.

If the motor speed is still relatively high when the master switch is returned to the off position, only the brake relay BR will be deenergized, because L and M will be maintained through contact CR and the normally closed interlock 4LA to contact No. 7 on the master switch. Since M is maintained, contactors 1L and 2A will also be maintained through their respective master switch contacts and the normally open M interlock. A negative torque in addition to the torque of the shunt brake will thus be maintained to provide a quick stop from full speed. As the motor approaches zero speed, relay contact CR will open to deenergize L and M which in turn will open the circuit to 2A and 1L. This disconnects the motor from the line and the load will be held by the brake.

Figure 8 — Comparison of typical speed-torque curves.



Operation of CR relay — Relay CR is controlled by utilizing the shift in the phase angle of the primary currents to operate it for maintaining the primary unbalanced voltages to the motor until the speed approaches zero.

A portion of the connection diagram taken from

Figure 5 is reproduced in Figure 6. Two vector diagrams are also shown in Figure 6 showing the current relationships obtained on the 1st point lowering for 30 per cent and 100 per cent slip, corresponding to 70 per cent and zero speed respectively; I1-I2-I3 represent the phase currents of a delta connected motor and i1-i2-i3 represent the unbalanced line currents. Vector diagrams for these particular speeds were selected to indicate how the phase current I3 decreases to a comparatively small value as the speed approaches zero. Note that phase current I3 is the only current in the system showing an appreciable change with change in speed. However, the angle of the line currents i1 and i2 shifts considerably as the speed changes. From these diagrams:

$$i2 = I1 - I3$$
$$i1 = I3 - I2$$
Therefore $i2 - i1 = I1 + I2 - 2I3$, but $I1 + I2 = -I3$
$$\text{Therefore } i2 - i1 = -3I3$$

This indicates that the difference between the line currents i2 and i1 varies in magnitude three times as much as the phase current I3. By using a pair of current transformers in the lines carrying currents i2 and i1, and connecting their secondaries to the CR relay coil, the relay operation will be controlled by the secondary currents. Since it is desired to control relay CR by the difference between line currents i2 and i1, the two transformers are connected to the relay with their polarities as shown in Figure 6. The relay is adjusted to close its contact at some current slightly above its opening value. With contactors L and 1L closed, which is the condition for the 1st point lowering, the CR relay will be energized by the current transformer an amount dependent upon the motor speed. As the speed decreases the relay current will be reduced, as described, and by adjustment its contact will open at some predetermined low speed. If the master switch is returned to the off position before this preset speed is reached, relay CR will cause contactors L and 1L to be maintained until the CR relay contact is opened. This method provides dynamic braking in the off position of the master switch until the motor has decelerated to almost zero speed.

Speed torque characteristic curves for the a-c hoist controller connected per Figure 5 are shown in Figure 7. The power hoisting curves are shown in the first quadrant, power lowering in the third quadrant, and dynamic lowering in the fourth quadrant.

Excepting for the 1st point hoisting all hoisting curves intersect at 100 per cent speed and zero torque. The slope of each curve is determined by the value of resistance in the secondary circuit of the motor. The curve for the 1st point hoisting is parallel to the curve for the 2nd point hoisting, and shows half the stalled motor torque as a result of opening one of the phases of the rotor circuit.

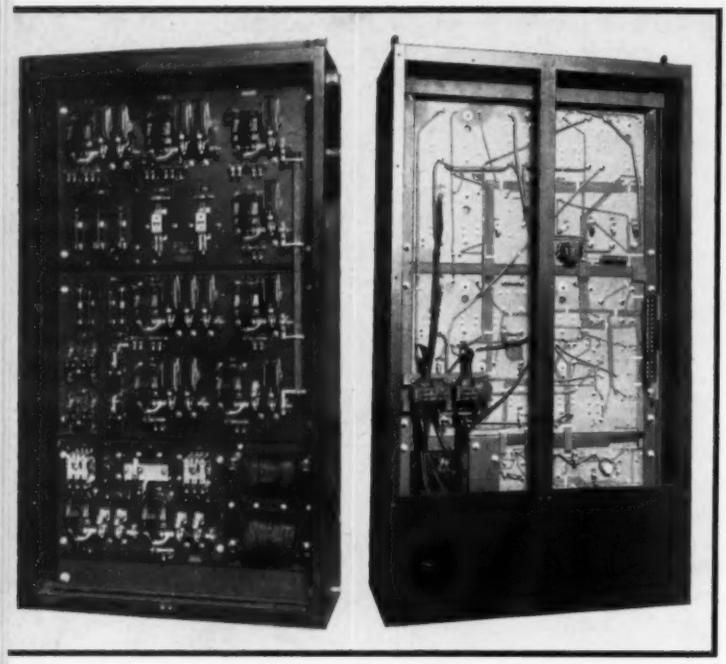
In the lowering direction all curves are practically straight parallel lines except the curve for the 4th point lowering. The 4th point lowering curve, while essentially a straight line, has less slope than the other curves. This shows that an objectionable change of torque would result at light loads if a transfer were made from the 3rd point curve direct to the 4th point curve, and that it is desirable to transfer from the 3rd to the 5th and then to the 4th point curve.

It might be expected, from the lowering curves shown for the first three points, that if the secondary resistor is not changed the slope of the speed torque curve will not be changed with changes in primary unbalancing only. Actually there is a negligible difference in slope for each of the first three points. As the primary voltage unbalancing is decreased, the slope of the resulting curve is reduced, and this changing in slope becomes more pronounced beyond the 3rd point curve. The slope of the 4th point curve could be increased to make it similar to the other curves (by increasing the secondary resistance) but the possible improvement in operation does not appear to warrant the added material required. The automatic method of transferring from the 3rd to 4th point accomplishes desired results quite easily.

The curves indicate that each speed point on the master switch will produce a definite speed change, and in the lowering direction the speed changes are practically the same regardless of the load. These characteristics indicate quite an improvement over those possible with the other a-c hoist schemes previously discussed.

It is generally desirable to have a "flat" speed torque characteristic, because this results in less speed change for changes in load. Figure 8 shows a group of typical speed torque lowering curves indicating the relative "flatness" of these curves for several types of hoist controllers. The curve shown for each type of controller is the one providing approximately 150 per cent speed for full load on the hook. Since only one curve has been selected for each type of controller represented in Figure 8 it does not show a complete picture of controller characteristics. The curve marked "All d-c" is for a standard d-c series wound motor controller, and is shown for comparative purposes. These curves present a comparative picture of the results obtained in the lowering direction when using a-c motors controlled by the various methods just described. The curves for counter torque and d-c braking are quite steep in comparison to the others. They do not pass through zero torque to the power lowering quadrant, indicating that these controllers are limited to overhauling loads. While the slope of the regenerative lowering curve is less (a "flatter" curve) this method is limited to applications on which lowering speeds less than 100 per cent are not required. All three of the foregoing types of controllers also have the undesirable characteristic of providing less speed change at light loads than at heavy loads. At zero torque the speed is the same on all master switch points. The unbalanced primary a-c curve is a reproduction of the 5th point lowering curve shown on Figure 7, and indicates the improvement in "flatness" as compared to the three foregoing curves. The slope of this curve is quite similar to the slope of the curve for the standard d-c series wound motor controller.

Figure 9 and 10 are front and rear view photographs of an a-c dynamic lowering crane hoist controller with primary voltage unbalancing for lowering. The auto transformer is supported from the frame. This requires the least amount of space for front and rear extension. The panels are mounted on a shockproof type crane frame to meet steel mill service requirements. All contactors and relays are heavy duty mill type.



Figures 9 and 10 — Front and rear views of a-c dynamic lowering crane hoist controller with primary voltage unbalancing for lowering.

Although the foregoing discussion is devoted to the magnetic controller, the same general characteristics of speed control may be provided by manual drum controllers. Some minor modifications in the voltage unbalancing circuit, such as adding resistors, may be required to insure against short circuiting the auto transformer by the drum controller.

Instead of using an auto-transformer to provide the unbalanced voltages other methods may be employed. The results obtained may be somewhat modified depending on the method considered and the economics involved. Unbalanced voltages may be provided by using resistors, reactors, or condensers.

The speed-torque characteristics displayed in Figure 7 may be compared to a rare book in a foreign language. If the reader is not familiar with the language, the contents are valueless. However if the characters represent something easily understood the information contained therein may suggest many new fields of application. These speed torque curves if thoroughly understood may indicate many other applications for this type of a-c controller. Since the lowering curves are practically straight lines for either positive or negative torque values, an unbalanced voltage type controller may be applied to advantage where loading conditions vary throughout this wide range. For example, the rotate motion for the boom on a ship may produce this load condition due to the listing of the ship. A modified form of this control has been applied to a drawbench drive to provide the high speed for drawing, and low speed at light load for hooking the carriage to the draw chain. Another application might be on a crane bridge or trolley drive to provide a retarding torque for slowdown.

While the a-c hoist controller described in detail appears to have many desirable features not possible with the other a-c controllers mentioned, it is not expected that it will bear the same relation to present standard d-c motor hoist controllers. It may be stated that this a-c hoist controller probably provides speed torque characteristics more like those of the standard d-c dynamic lowering hoist controller than any of the other a-c hoist schemes.

In making general comparisons between this new a-c, and the standard d-c, dynamic lowering hoist controllers for applications on which a choice between the two is being considered, certain limitations should be taken into account. In case of power failure the a-c motor will not produce dynamic braking which is possible with the d-c motor. Limit stops arranged to provide dynamic braking cannot be readily applied to an a-c motor. A-c motor installations on cranes require more main trolley circuits. It may be felt that d-c brakes generally are superior to a-c brakes in many respects, and certainly a good brake is important for accurate spotting of loads on a crane hoist. D-c shunt brakes however may be used without much difficulty on a-c installations, by installing rectifiers for them.

There will undoubtedly still be many installations for which direct current will be the logical choice. However it is thought that the method described in this paper gives, for the first time, suitable safe and stable lowering speeds with alternating current, over the whole range of loads. This will permit the use of alternating current, with all of its advantages, for many installations for which it could not previously have been considered.

DISCUSSION

PRESENTED BY

A. H. MYLES, Assistant Chief Engineer, The Electric Controller and Manufacturing Company, Cleveland, Ohio

C. B. RISLER, Industry Engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania

W. C. RAUBE, Application Engineer, General Electric Company, Schenectady, New York

E. J. POSSELT, Assistant Supervising Engineer, Cutler-Hammer, Inc., Milwaukee, Wisconsin

A. H. Myles: I think we will all agree that general purpose crane performance obtainable when powered by d-c motors is superior to anything yet obtainable with a-c, but rapid strides are being made in the development of a-c control and the gap is certainly being narrowed.

In the author's introductory description of various a-c hoist controllers he states: "By short circuiting one pair of the motor primary or stator terminals and applying single phase to the remaining circuit, regulation below synchronous speed can be obtained with overhauling loads. This feature is sometimes used in addi-

tion to the regenerative braking method just described in order to obtain regulation below synchronous speed." I am quite familiar with this circuit (Figure A), having been associated with its development and application to some 300 cranes now in use. The author's reference to this circuit omits some essential features that I would like to discuss briefly.

With this short circuiting connection on the motor primary, it is also, as in the author's method for control, very necessary to insert resistance in the rotor circuit. The value of this resistance has a very definite bearing on the amount of braking torque.

The author, in mentioning the single phase connection, states that regulation is obtained below synchronous speed. No doubt he realizes that this braking torque also increases with speed above synchronism.

In the presentation of his paper, the author has shown how lowering operation is obtained by using various amounts of unbalance on the motor primary. The degree of unbalance varies from nearly a three phase balanced primary connection with "down-power" through various steps of unbalance approaching a single phase connection and then still greater unbalance by use of an overhanging winding in the auto-transformer, giving a reversal in phase sequence or a contra-torque condition.

In a controller using this circuit, an unbalanced primary condition also exists, but on the single dynamic lowering point only. (See Figure B). I believe we are all familiar with the fact that the motor phase currents are greatly increased when we unbalance the primary voltages.

The author's paper does not give any values of current on the various lowering steps. I would like to ask if he can tell us anything about the current values for each step.

It has been our experience in hoist applications, especially 40 hp and under, where most crane motors are rated on a half hour basis, that it is more practical to do most of the lowering at full speed or on regeneration with a balanced primary circuit; and to slow down and land the load on a single dynamic braking point, which removes the temptation to lower for long periods on points that would produce unnecessary heating of the motor.

I would like to refer to an essential control feature stressed by the author: the need for retaining a dynamic braking connection on the motor after the master has been returned from "lower" to "off" position in order to help the brake stop the load. This feature has an important advantage, often overlooked, in that electric braking is maintained during the setting of the magnetic brake, thus preventing the load from dropping in this short time interval. Just as the motor comes to rest, the dynamic braking circuit must be opened. As in the case of the author's control we also provide this feature, but by the use of the frequency relays used for normal acceleration.

I would now like to describe a further extension to this general system of control for installations where it is necessary to lower overhauling loads at low speeds through considerable distances. An exemplary installation of this type is a shipway crane where it is necessary to lower through hatches where the operator cannot see the load and must be guided by signals. With an unbalanced dynamic braking connection, this service taxes the heating capacity of the motor. For such applications we have developed a combined selective dynamic contra-torque lowering controller (Figure C). The master switch handle of this controller includes a push button. Disregarding the push button, this is a dynamic lower-

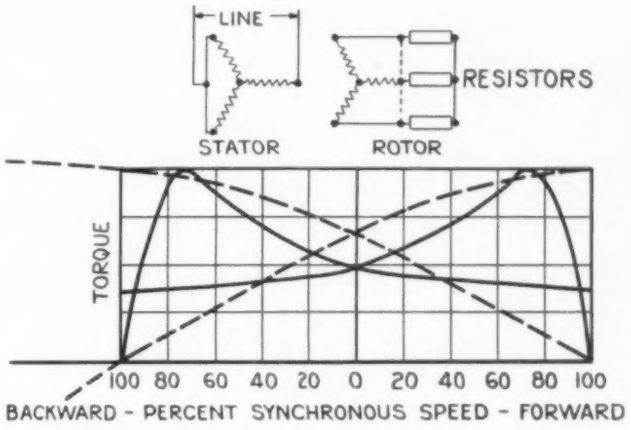
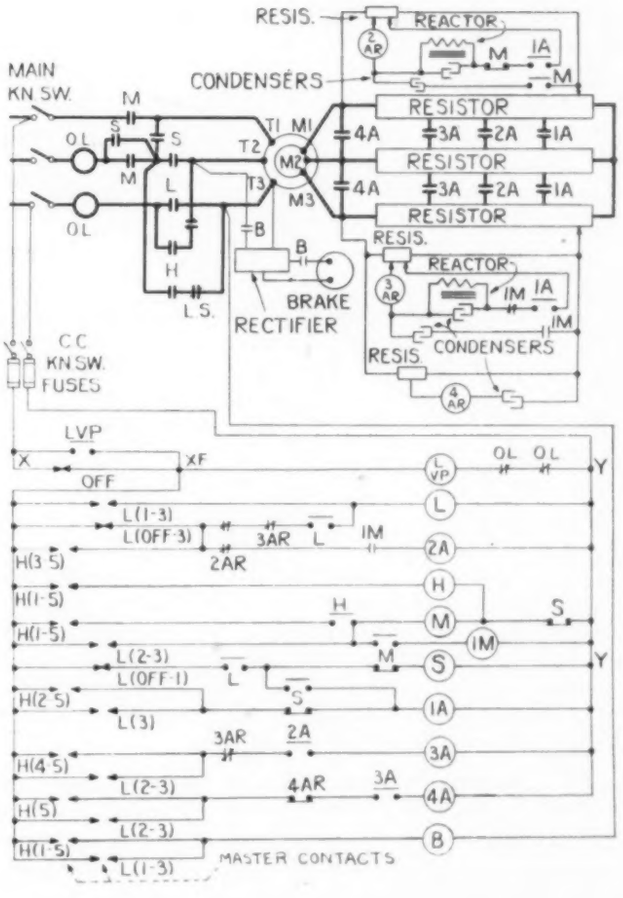


Figure A — Dynamic lowering controller characteristics.

Figure B — Wiring diagram for dynamic lowering controller.



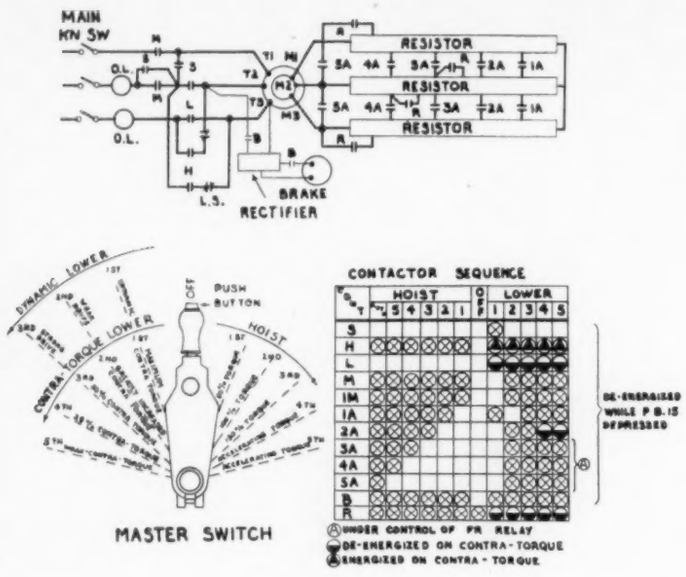


Figure C — Sketch showing principles of combined selective dynamic or contra-torque controller.

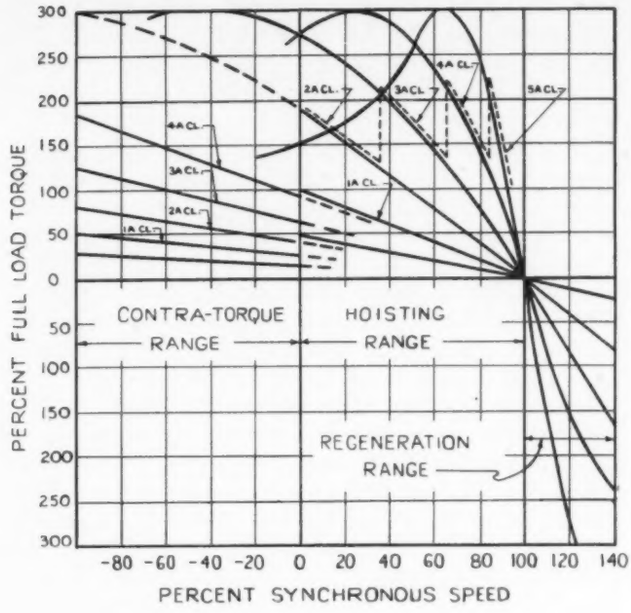


Figure D — Speed-torque curves for combined selective dynamic or contra-torque controller.

ing controller as already described. However, it can be instantly converted while lowering to a contra-torque controller by operating the button in the master handle.

When the operator wishes to lower a load at reduced speed, he depresses the master push-button and moves the handle in the lowering direction to any desired point and then releases the button, instantly obtaining the selected contra-torque value. It is not necessary with this controller to apply "down-power" prior to establishing contra-torque, as is generally the case on contra-torque controllers.

It will be noted that the contactor "R" is open on all points of contra-torque lowering, inserting extra resistance in the rotor circuit. This extra resistance is so distributed and of such value that very satisfactory speed control is given over a wide range of loads. (See Figure D).

In order to lower loads of moderate size, a very weak contra-torque must be applied to the motor to allow overhauling. It then becomes necessary to provide protection against over-speeding should the operator attempt to lower a heavy load on these weak contra-torque points. To provide this protection, a relay responsive to the rotor frequency or motor speed is used to increase, automatically, the value of contra-torque at some predetermined speed usually 15 to 20 per cent above synchronous speed.

C. B. Risler: As a contribution to the discussion of Mr. Posselt's paper and to establish further background for the consideration of the control system he has introduced, I wish to submit the speed torque characteristics of the various crane control systems used to date. These were discussed in the first portion of Mr. Posselt's remarks. The curves are a result of comprehensive tests and are plotted on a percentage basis and thus are comparable to those used in illustrating the control system just presented.

Figure E, shows the characteristics of d-c control, aptly spoken of as an "all d-c" type of controller with a series wound motor and operated from a d-c power supply. It provides, in the hoist direction, the general characteristics attributed to series motor and in the lowering direction provides the flat dynamic braking characteristics, permitting the lowering of heavy loads at low speed or high speed but at the same time, requiring rapid manipulation of the master switch in order to get spotting in the extreme low speed region, since at 70 per cent torque the lowest speed obtained is 30 per cent. Note the positive down torque available for power lowering of a non-overhauling light hook.

The characteristics of a counter torque controller are shown in Figure F. The speed-torque curves converge at 100 per cent synchronous speed in the hoist direction, resulting therefore in curves which cross the zero speed axis and give a tendency to hoist a load if perchance the operator should be working on the wrong point of his master switch. This is particularly troublesome when loads vary considerably in weight and requires, therefore, careful master switch manipulation.

In the low torque region the absence of good curve coverage makes handling of light loads a difficult problem. Again, to lower your heavy loads at a slow speed for spotting, operation can be secured due to the number of speed torque curves available but requires careful master switch manipulation. This type of control has found wide acceptance in bucket work where you have two definitely predetermined loads.

Figure G, shows the characteristics obtainable with d-c excitation of the wound rotor motor in the lowering

direction. Again, as remarked by Mr. Posselt, the hoist curves are generally comparable throughout the whole line of a-c controls and I shall not discuss them. Note the general fan of curves which converge at the zero speed, zero torque point and the flat slope available especially at the low speeds. This is indicative of good speed regulation. I would like to add that a flatter curve than this can be obtained which will give a value of about 5 per cent speed at 100 per cent motor torque. This curve provides a fine characteristic for extremely slow lowering of heavy loads or overloads as may be required. It really provides a creeping speed.

I would like to amend Mr. Posselt's explanation to add that the dry type rectifier has also been used by us as a source of low voltage d-c potential for excitation with this control.

In Figure G, as also in Figures F and H, a curve is shown for the regenerative braking providing a very flat speed-torque characteristic at 100 per cent lowering speed. A series of curves will fan out (down and to the right) from this 100 per cent speed point in approximately straight lines anywhere within the operating range. For crane hoist drives regenerative braking type of control should not be considered so much on its merit alone, but as an adjunct to one of the other types — counter torque, d-c dynamic braking or a-c dynamic braking. When used together with them, it does have considerable merit and is a contributing factor to good performance. Note that with the regenerative and the d-c dynamic braking control combined you get fine speed regulation in both the full speed and low speed operating zones for any range of load even well beyond 100 per cent.

Figure H presents the characteristics of the a-c dynamic braking type of control mentioned in the previous discussion. It is obtained by shorting one winding of the motor and applying single phase to the remaining two terminals. This method of connection was originally

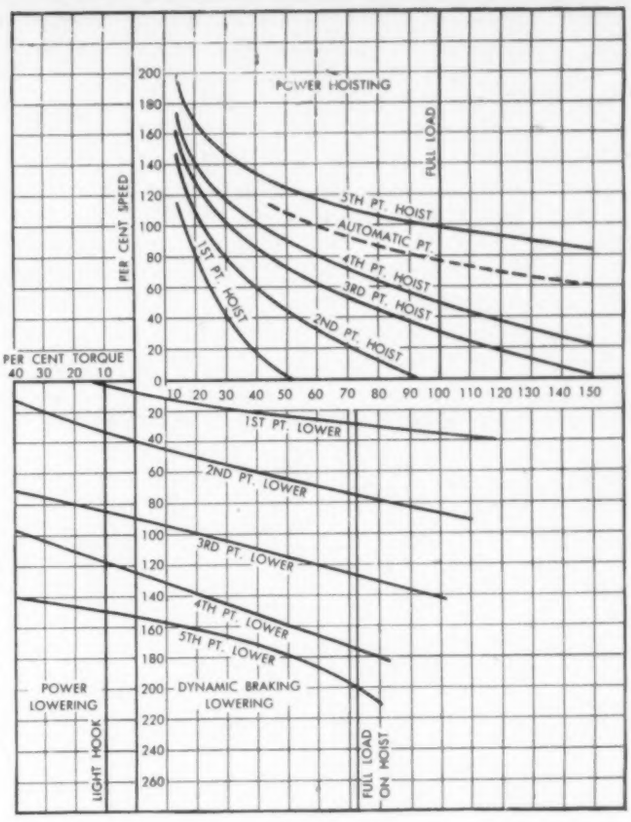
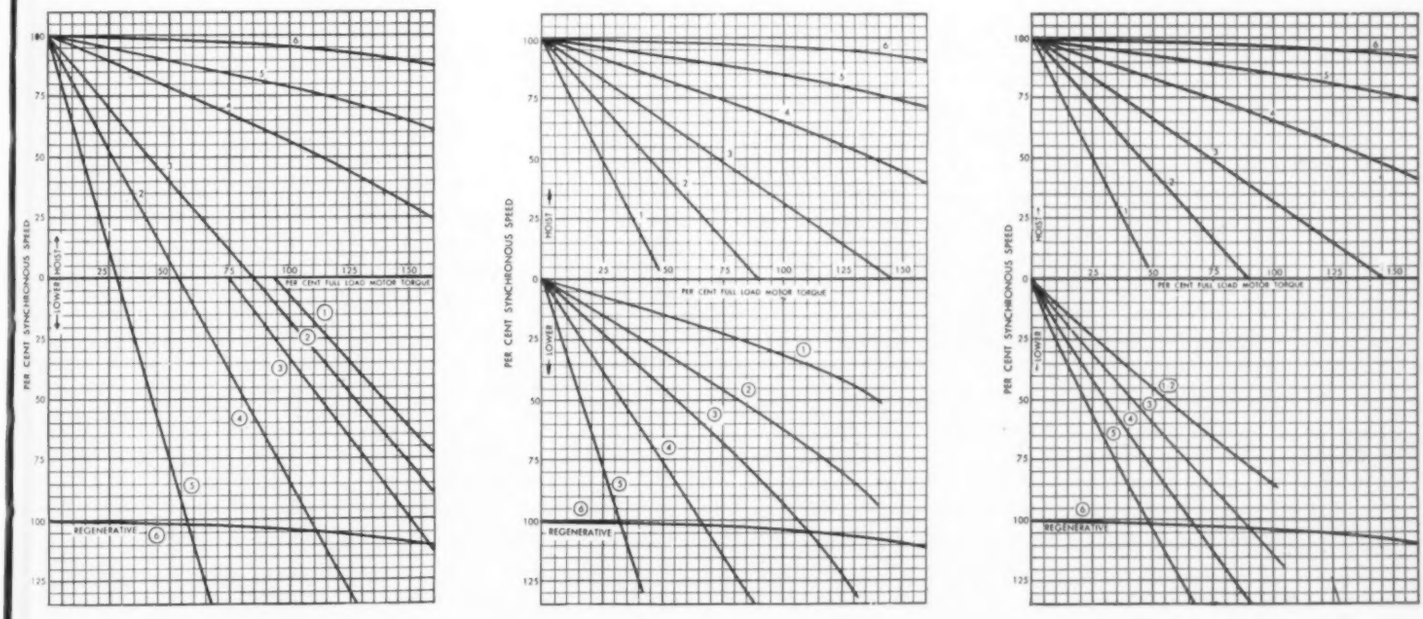


Figure E — (top) Characteristics of d-c crane hoist control.

Figure F — (bottom left) Characteristics of counter-torque controller.

Figure G — (bottom center) Characteristics of d-c dynamic type control.

Figure H — (bottom right) Characteristics of a-c dynamic braking control.



developed in Germany and as a single phase connection it is in a sense a special case of the control as discussed by Mr. Posselt. The curves again converge at zero torque and zero speed. Combined with the regenerative type of braking it has merit in retarding loads from 50 per cent torque down, where the crane is generally moderately or lightly loaded. A weakness is evident in the heavy load, low speed zone and as explained previously, this area is covered by the use of counter torque control. So, by combining the three types of control, regenerative, a-c dynamic and counter torque, the working area is covered. Test results in the field and experience with this control generally have indicated motor currents of approximately 200 per cent.

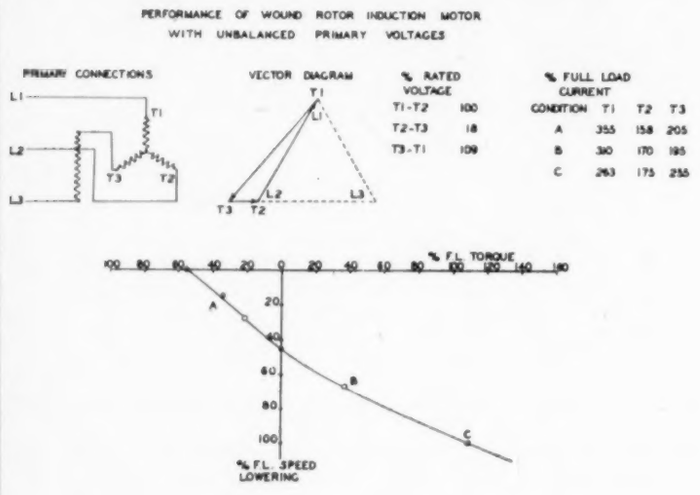


Figure J — Results of tests using unbalanced voltages in a-c hoist.

Figure J, shows the result of further testing with unbalanced voltages with a connection which closely parallels that used by Mr. Posselt. The method of connection is given in the upper-left hand corner. The speed torque curve obtained very closely substantiates the information presented by Mr. Posselt in his paper. We are highly in agreement with the value of the curve which in this case as in the d-c series control, crosses the zero torque axis and provides ability to handle a light hook at low speed. Light hook handling at the higher speed can be obtained with the regenerative lowering connection which provides a motoring characteristic at approximately synchronous speed.

I call your attention to the current values obtained with such an unbalanced connection. The conditions are given for points A, B and C on the curve and the currents were measured at terminals T-1, T-2, and T-3 of the motor. The values are per cent of rated full load motor current: for point A, 355, 158 and 205 per cent, point B, 310, 170 and 195 per cent and point C, 263, 175 and 255 per cent. Such current characteristics, present in these unbalanced systems, must be borne in mind when applying motors and contactors, especially when heavy duty repetitive operation is indicated.

Mr. Posselt refers frequently to control characteristics at speeds of 150 per cent synchronous. I would like to call your attention to the N. E. M. A. standardization on overspeed for wound rotor motors. The limits are 125 per cent for four pole, 1800 rpm machines and 150 per cent for 6 pole, 1200 rpm and slower. With control designed to utilize all speed up to the standard limit the motor manufacturer should be warned to permit the special design of some additional margin of safety into the machine.

The first hoisting point shown for this new control is of considerable interest. I understand this point is secured with three-phase balanced voltages applied to the stator and a single phased rotor with resistance which with three-phase would give 100 per cent torque at standstill. I am well familiar with the characteristic of a wound rotor motor with low resistance single phased rotor and three-phased stator which gives approximately half speed operation at zero torque while motoring. However, I am not aware such operation can be consistently obtained with the higher value of rotor resistance used in this case.

Mr. Posselt's concluding remarks regarding the relative suitability of a-c and d-c drives for crane hoists and the advantage of using d-c brakes on a-c cranes to secure more sturdy construction and snappy operation meet with my hearty endorsement.

W. C. Raube: In opening my discussion, I wish to review briefly the different schemes that have been discussed. The attainment of braking torque at subsynchronous speeds on polyphase induction motors has been an alluring goal for many years. In general, all known schemes, of which there are quite a few, including the scheme described by Mr. Posselt, may be classified in four groups.

1. Balanced three phase counter-torque or plugging.
2. Single phase alternating current applied to the stator windings in various combinations.
3. Application of unbalanced three phase alternating current to the stator windings with or without various combinations of reversed phases.
4. Excitation of stator windings from a direct current source.

Mr. Posselt's scheme, of course, falls in the third classification.

The counter-torque scheme while in general satisfactory for such applications as grab bucket and lifting magnet hoists in scrap yard service, is not suitable where fairly accurate inching and spotting of loads are required. The reason for this is that small changes in load result in wide changes in speed, and with light loads actual reversal of hook movement will occur. This resulting variation in speed on a given counter-torque point on the control dependent on the load condition is very disconcerting to the hoist operator.

The speed regulation with different overhauling loads on the single phase scheme of control is somewhat better than that obtained with the counter-torque scheme; however, the slowest speed that can be secured with full load on the hook is approximately 60 per cent of rated hoisting speed. The above is based on an overall hoist efficiency of 80 per cent.

Mr. Posselt has already illustrated in his Figure 7, speed torque characteristics obtained with an unbal-

anced three phase voltage scheme of control. As the curves indicate, the speed regulation is superior to either counter-torque or single phase braking.

Of the known electric braking schemes, the one in which the stator windings of the hoist motor are excited from a direct current source gives the best speed regulation, i.e., minimum speed change for different loads and also the slowest speeds for lowering heavy loads. For example, it was possible to lower full load at a stable speed of approximately 5 per cent of rated hoisting speed on a large crane using two 250 hp wound rotor hoist motors.

This scheme of control is usually arranged to provide subsynchronous braking lowering speeds on the first three or four positions of the master switch. On subsequent lowering positions, the stator is connected to the a-c supply whereby an empty hook or very light load may be driven down at slightly below synchronous speed of the hoist motor, or overhauling loads will lower at slightly above synchronous speed by a-c regenerative braking or at super-synchronous speed if a section of the secondary resistance is left in the rotor circuit. The speed regulation with a-c regenerative braking is much superior to that obtained at high speed with d-c excitation of the stator. There is no object, therefore, in using d-c excitation for lowering overhauling loads at above synchronous speed.

In the discussion of control systems, the effect on the motor is often overlooked. The user of the hoist is vitally interested in this phase of the hoist drive and it should not be treated lightly. The use of single phase and unbalanced three phase braking schemes of control results in high unbalanced motor currents. For example, the current values in each phase of a typical motor for the single phase scheme when lowering full load (64 per cent torque at motor shaft) are as follows, based on the secondary resistor being adjusted for obtaining the minimum speed as outlined in a preceding paragraph:

Phase	Per cent of rated primary phase current	
	Primary connected delta	Primary connected wye
1	170	177
2	155	137
3	107	118

Similarly, the phase currents in the same motor when lowering full load (64 per cent torque at motor shaft) with the unbalanced three phase voltages and secondary resistance corresponding to point on lowering as described by Mr. Posselt, are as follows:

Phase	Per cent of rated primary phase current	
	Primary connected delta	Primary connected wye
1	218	236
2	198	146
3	98	110

The phase currents when using d-c excitation of the primary are as follows:

Phase	Per cent of rated a-c primary phase current	
	Primary connected delta	Primary connected wye
1	200	175
2	100	175
3	100	0

That high unbalanced currents are obtained with both a-c systems of control is logical when one remembers that the braking torque produced is the result of two opposing torques and as a consequence high internal heating of the motor takes place.

Internal heating of an induction motor is made up of three components. There is the heating due to the I^2R in the primary, the I^2R of the secondary and that due to core loss. In order to obtain an accurate gauge of the heating in the motor it is not correct to consider only the I^2R in the primary but all three of the contributing factors must be considered.

From the above tables, it is immediately apparent that the heating in the primary winding is higher than that produced under normal three phase operation at rated load. The overall heating in primary is approximately three times normal in the case of the unbalanced three phase braking scheme of control and just slightly over twice normal in the single phase braking and d-c braking schemes, all for the condition for which the above tabulation was developed. The overall heating due to I^2R loss in the secondary is nearly four times normal for the unbalanced three phase braking scheme of control, a little over double in the case of the single phase braking scheme and only a small fraction of normal in the case of the d-c braking scheme of control. The core loss in the case of the unbalanced three phase and the single phase a-c braking schemes is somewhat less than normal or approximately 75 per cent and very materially less than normal for the d-c braking scheme of control. The combined effect of these components results in an average heating of approximately 250 per cent of normal in the case of the unbalanced three phase braking scheme of control, approximately 185 per cent in the case of the single phase braking scheme of control and just under 100 per cent for the d-c braking scheme of control.

The very large difference between the rotor loss for the d-c and the a-c systems of braking control is due to three causes:

a. The d-c system rotor circuit must dissipate or absorb only the energy given up by the lowering load. In addition to this, the a-c systems feed a large amount of power into the rotor circuit through the primary supply which must likewise be dissipated in heat.
b. For the same speed, the d-c system requires considerably greater external resistance so that a greater percentage of heat is dissipated outside the motor for the d-c system.
c. As was mentioned before, the torque in the a-c systems is the difference of two opposing torques while the loss in these systems is the sum of the squares of the corresponding currents. For the same torque, the loss in the a-c systems is inherently higher than for the d-c system.

In fairness to the unbalanced a-c voltage system, it is to be noted that the rotor copper loss becomes progressively less by appreciable amounts on points 2, 3, 4 and 5 lowering.

Another interesting fact is that in the unbalanced three phase voltage scheme the currents in the three phases of the power line also are unbalanced. At one speed obtained with connection corresponding to point 1 lowering these were:

L1 — 240 per cent
L2 — 336 per cent
L3 — 100 per cent

I should like to inquire what effect these currents have upon the selection and maintenance of the primary contactor.

There is one comment I should like to make in connection with speed-torque curves shown in Figure 7 of the paper. The curve for point 1 hoisting is drawn between 50 per cent torque at zero speed and 50 per cent speed at zero torque. Since the primary is balanced, three phase, and even though the secondary resistance is only connected across one phase, the upper end of this curve should culminate at 100 per cent speed and zero torque. We appreciate that there is a slight reduction in torque at 50 per cent speed due to the single phase secondary connection but the torque does not decrease to zero as shown. Consequently, light hook speed on point 1 hoisting will be between 75 per cent and 90 per cent depending upon the mechanical efficiency of the hoist instead of less than 50 per cent as shown.

When comparing different schemes of control, there is always room for honest difference of opinion. This applies to some statements presented in the paper.

Mr. Posselt made the statement that counter-torque control may, for practical purposes, be considered the same as d-c dynamic braking on an induction motor and states further that counter-torque is usually preferred over the d-c braking scheme. The counter-torque scheme, correctly applied, is an excellent control, but its extremely sensitive and wide speed variation for small changes in load make it very inferior to d-c braking on an induction motor where accurate slow speeds and positioning are required. This has been proven by reports on similar cranes in the same shipyard using the two kinds of control, where in every case the d-c induction motor braking is preferred. In fact, in several shipyards, counter-torque control has either been changed to d-c braking or the change is now under consideration because of unsatisfactory performance of counter-torque where accurate control is required.

Reference has been made to the necessity of going to point 5 lower to drive a light hook down when using d-c braking on an induction motor. It is easy to arrange the control so that a light hook may be lowered on any lowering point and a great many controls are so operating.

There is also room for an honest difference of opinion with regard to the speed-torque curves in Figure 8 of the paper. The solid curves in the accompanying sketch (Figure K) show the recommended lowering curves obtainable with an induction motor in combination with d-c excitation of motor primary for dynamic braking lowering. Curves 1L, 2L and 3L are obtained with d-c excitation of the motor primary in combination

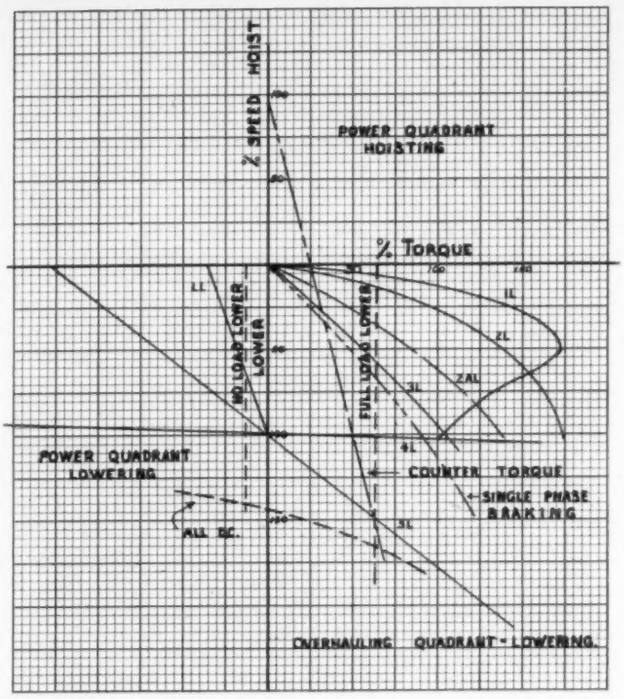


Figure K — Speed-torque curves with various methods of hoist control.

with proper values of secondary resistance and provide good speed regulation. Curve 4L shows the full speed characteristic as a balanced three-phase induction motor, providing power for motoring an empty hook or regenerative braking for overhauling loads. Speed regulation is excellent. Super-synchronous speed with overhauling loads can be obtained by maintaining the balanced three-phase induction motor connections and connecting some resistance in the secondary circuit for regenerative braking as represented by curve 5L. Curve LL shows the speed torque curve that can be provided on the a-c-d-c dynamic braking control scheme for jogging an empty hook in the lowering direction.

For comparison, the "all d-c" curve is shown in broken line, and the counter-torque curve in dot-dash line. The dot-dot-dash curve shows the lowest speed braking characteristic obtainable with the single phase a-c braking system.

E. J. Posselt: From the discussions submitted, the one question which seems to come to the front is that of the currents in the various phases with unbalanced primary voltages. I believe it has been shown that the currents are rather high. They are above normal, and it has been stated that in some of these other schemes the currents are also above normal.

I am not prepared to state definitely what the effects of these currents are. But I believe we might consider them by a comparison with the conventional direct current motor; that is, consider the currents in the various circuits of a direct current motor and compare them with an a-c motor under the same conditions. This will give us some picture of how a motor has been operated previous to this and what we might expect from the a-c motor under similar conditions.

D-c dynamic lowering hoist controllers, as we all know, are arranged to connect the series field through a resistor across the line; in other words, to obtain shunt characteristics. Under these conditions, the current obtained in the series field and also in the armature of the motor is quite high. I believe the figures are something like 170 per cent in the series field and about 60 or 70 in the armature.

If we did not have previous experience and we thought of these high currents in a direct current motor, we might attempt to discuss the effects of these high currents and state that we are going to have trouble with motor burn-out.

Now we have the question of high currents in the unbalanced primary scheme, and I believe I should correct some of the values which were submitted. The currents in two of the phases on a delta-connected motor are about 220 per cent, and the third phase about 90 per cent.

There is one difference to be considered between the design of a d-c motor and that of an a-c motor. An a-c motor is designed to produce a certain pull-out torque, with the result that it probably has excess heating capacity when compared to a d-c motor. This would indicate that we should be able to overload an a-c motor more than a d-c motor, because the motor has excess heating capacity compared to a d-c motor.

We might discuss this question for a long time. Another answer to this would be that hoist controllers are in operation using this scheme, and so far have proven satisfactory under normal conditions.

The point raised about using this system on a hoist which may lower on the first point or at low speeds for a long period of time also applies to d-c motor hoists. In other words, if we have a hoist that requires about seven or ten minutes to lower and it is necessary to lower at a low speed, the d-c motor is going to be overheated and so will the a-c motor. Probably I neglected to mention that this is one of the limitations of this a-c hoist scheme. It is necessary, as in all other applications, to know the requirements of the application and, knowing the requirements, properly apply the control to do the job.

We are not attempting to state that satisfactory results cannot be obtained by other methods. The only thing I have tried to show is that we are attempting to produce results similar to the d-c type of control, and showed one method of doing it. No doubt there are other methods. The fact is, we are still experimenting with the a-c dynamic lowering hoist scheme, and we hope sometime in the future to have something else to offer along the same lines.

The values shown on the curve for the first point hoisting were determined by calculation and checked experimentally. I am not in position to say that the speed will be 50 per cent with the unbalanced secondary circuit or will be 80 per cent. It is information that was given to me, based on calculations and test results.

It is true that because of the high primary currents consideration should be given to the selection of contactors. We know the line currents, in certain lines will be higher than in other lines, and therefore it is necessary to make provisions to handle these higher currents and stay within the rating of the contactors. One method for accomplishing this is to use two poles of the three-pole contactor in parallel to take care of the line with the higher current, and use the remaining single pole in the line which is commutating the lower current.

The data submitted by Mr. Risler in Figure J of his discussion is probably correct for the curve indicated. This curve, however, does not duplicate any of the curves shown in Figure 7 of my paper. The slope of the curve produced by Mr. Risler is less than any of the lowering curves in Figure 7 excepting for that shown for the fourth speed point. His vector diagram indicates unbalanced primary voltages slightly less than those for the second speed point but greater than those for the third speed point, as is noted by comparison with Figure 4 of my paper. In the zone of the speed-torque curves, for this amount of primary voltage unbalancing, it is necessary to use less secondary resistance to obtain the flat characteristic produced by Mr. Risler. From the data he has submitted, it appears that the secondary resistance necessary to produce his curve is quite low. To obtain the stalled net torque of 55 per cent with the unbalanced voltages tabulated by Mr. Risler, the secondary resistor would have to be a value which would produce approximately 305 per cent stalled torque with a balanced three phase voltage of 100 per cent. This will, of course, result in high motor currents as he has indicated. This is the price paid to obtain a speed-torque curve with less slope than those shown in Figure 7 of my paper.

The secondary resistances used in Figures 4 and 5 to produce the speed-torque curves as shown in Figure 7 of my paper are such as to limit the motor currents to a safe operating value. For the purpose of comparison, the currents for operating at point B, on a characteristic curve with the slope shown in Figure 7, are about 60 per cent of those tabulated by Mr. Risler.

It is important, when making comparisons as has been attempted in the discussions on my paper, that all essential factors be included. Mr. Raube presented data showing motor currents for several methods of control. The values specified for the scheme I described are in agreement with those which we have experienced. The values tabulated for the single phase control scheme are not comparative to those of the unbalanced voltage scheme as evidently the values are for different speeds.

Analysis and tests indicate that due to the net negative (hoisting) stalled torque and the overvoltage provided by the particular method of unbalance as described in my paper, the motor currents are lower than can be obtained by any other unbalance scheme including the single phase connection for the same speed-torque point. Therefore, to keep the motor currents within safe operating values, less desirable speed-torque curves must be accepted with the other unbalance schemes.

As indicated in all the discussions, consideration of the application is important, since modifications of the control scheme may be necessary to satisfy special operating conditions. On the basis of the favorable speed-torque curves provided by the method described in my paper, this scheme may be used without modifications, for a wider range of applications than was previously possible on alternating current.

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KING *Discussion*

(*Continued from page 61*)

month in which we expect to ship that material. Today we have schedules for various order items divided into specific months, months in advance. The customer has the assurance that unless WPB issues another or revises a directive, or something happens in the labor field, or an act of God occurs, he is reasonably certain to get that material in the month promised by the company.

And as we approach the actual detailed scheduling, we endeavor to promise the shipment of material within ten days of when it actually will be shipped. We keep a control record on these reports, or the movements through reports, and any promises that are not lived up to by the plants are reported. And we have a competitive system between plants, so that there is a little rivalry in trying to better their broken promise performance.

Flexibility under normal conditions will be largely dependent on the amount of government control exercised.

J. B. Copper: Getting back to the production control and scheduling, we talk mostly about building back from the order to the hot metal required. In our steel company, where we also produce the raw materials, I would like to hear some discussion on whether or not this same production scheduling and control system would apply. Would you build back to the point where you start with the coal and the ore?

L. J. King: One of the functions of production planning and control which is usually performed in the various departments is that of long range planning and forecasting. In the northern steel companies, where we have to bring down the ore during the summer months on the Great Lakes, it is obvious that we have to plan or forecast our production requirements of ore for a period of at least a year ahead. That is done on the basis of the order volume, modified by market and war conditions. For instance, the forecast might be no good for the next year if the war were suddenly to end tomorrow. Always with a factor of safety, we have to plan at least a year ahead on our ore requirements.

And also, through the market research in the sales department and the forecasting group in the engineering department, we have projected plans for production far in advance.

Those factors all taken together should be the basis of any development program so far as raw materials requirements are concerned.

T. W. Boone: In order for production planning and control to function, how accurate do you think daily figures regarding consumption of time and materials should be, and especially on a blast furnace operation, how accurate should they be on a daily basis?

L. J. King: Your records probably, so far as utilization of the materials produced, such as pig iron, are concerned, should always be accurate, if for no other reason than the record of the production.

Bloom and Billet Mills AND THEIR ROLLS

. . . . presenting layouts of blooming and billet mills of various types, with typical roll passes, and discussing roll applications in these mills . . . .

by F. C. T. Daniels AND D. L. Eynon
MACKINTOSH-HEMPHILL COMPANY
PITTSBURGH, PENNSYLVANIA

▲ IN attempting to cover the wide field implied by this subject without exceeding space limitations, it is felt that it is best to rely on extensive pictorial treatment of the mill layouts and roll pass designs, coupled with a discussion of some pertinent points concerning roll application. In general, the layouts speak for themselves and we will proceed to the subject of rolls.

One of the many things entering into the design of rolls is whether or not ragging the rolls is permissable. It is greatly dependent upon the composition of the steel being rolled and also upon the class of product. There are about as many types of ragging as there are roll designers. Some ragging is chipped in by hand, often mere gouges in the surface of the roll, others are cut by means of specially designed machines and still others are knurled, where only a small ragging effect is permissible. Ragging should be avoided wherever possible.

The use of cooling water also shows a wide variation from mill to mill. The best accredited practice is to use copious quantities of water at a moderate temperature and applied with as low a pressure as possible, preferably towards the delivery side of the roll to avoid entrapping the water in the passes. In many cases the bottom rolls are insufficiently cooled and they are the ones that frequently fail first.

High pressure water that is used for scale removal should be so directed as to avoid blowing scale into the passes and sprays should be placed far enough away from the rolls so that the excess water may be permitted to evaporate before the piece enters the rolls. One plant has the practice of blowing high pressure steam onto the piece directly as it enters the rolls, claiming thereby to remove the scale and blow it out from the rolls.

The use of individual drives for the stands of a continuous mill is a decided improvement on the older practice of a single drive with all the stands geared together making fixed speeds at each stand. Lack of flexibility in the latter layout causes special design problems in order to effect the desired reduction and shape per pass and still maintain the regular flow of the billet, from stand to stand, without pulling or looping between stands.

Furthermore, the sizes of the rolls that can be used in individual stands is fixed because of fixed speeds. The rolls are usually installed in sets and all are carried down together. Excessive wear on the rolls of one stand causes excessive diameter reductions when dressing on the whole line of rolls. Some mills carry spare pairs of rolls to use in the excessive wear stands, while others have ingenious methods of changing their rolls about in the various stands, but the individual drive, with its speed controls, is the best answer.

The trouble encountered in continuous mills from the tendency of twist guides to open up seams in the material is well known, and various methods have been used to overcome it. Twist guides with rollers incorporated are used. Also, as indicated in the accom-

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 28-30, 1943

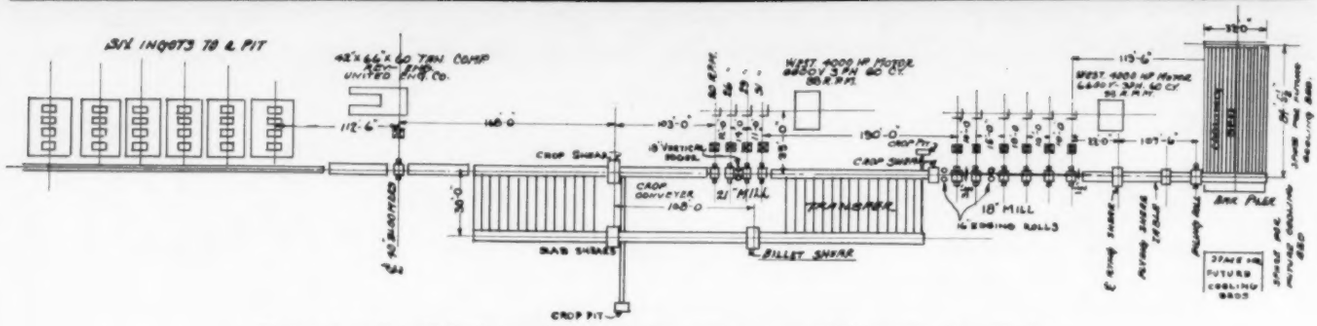


Figure 1 — Small billets and sheet bar are produced through the 21 in. and 18 in. mills. Slabs are taken from the mill over the first transfer.

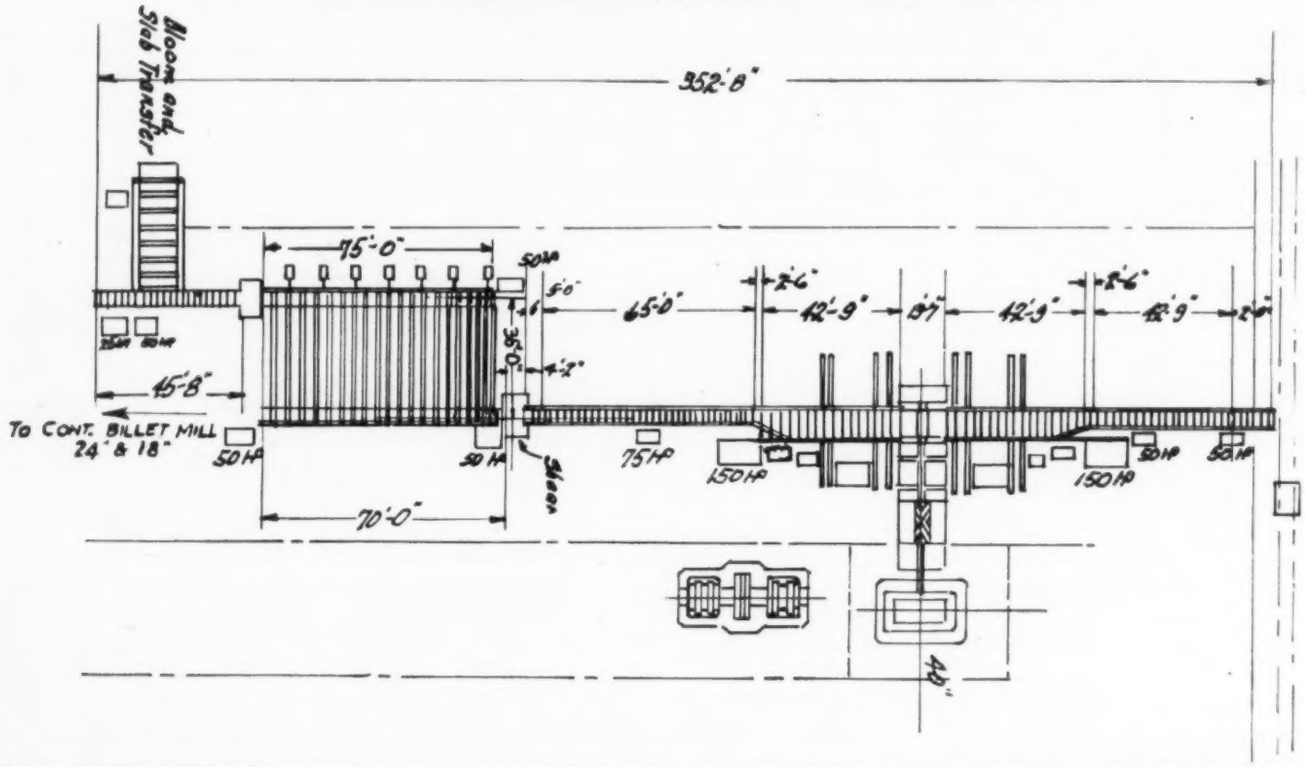
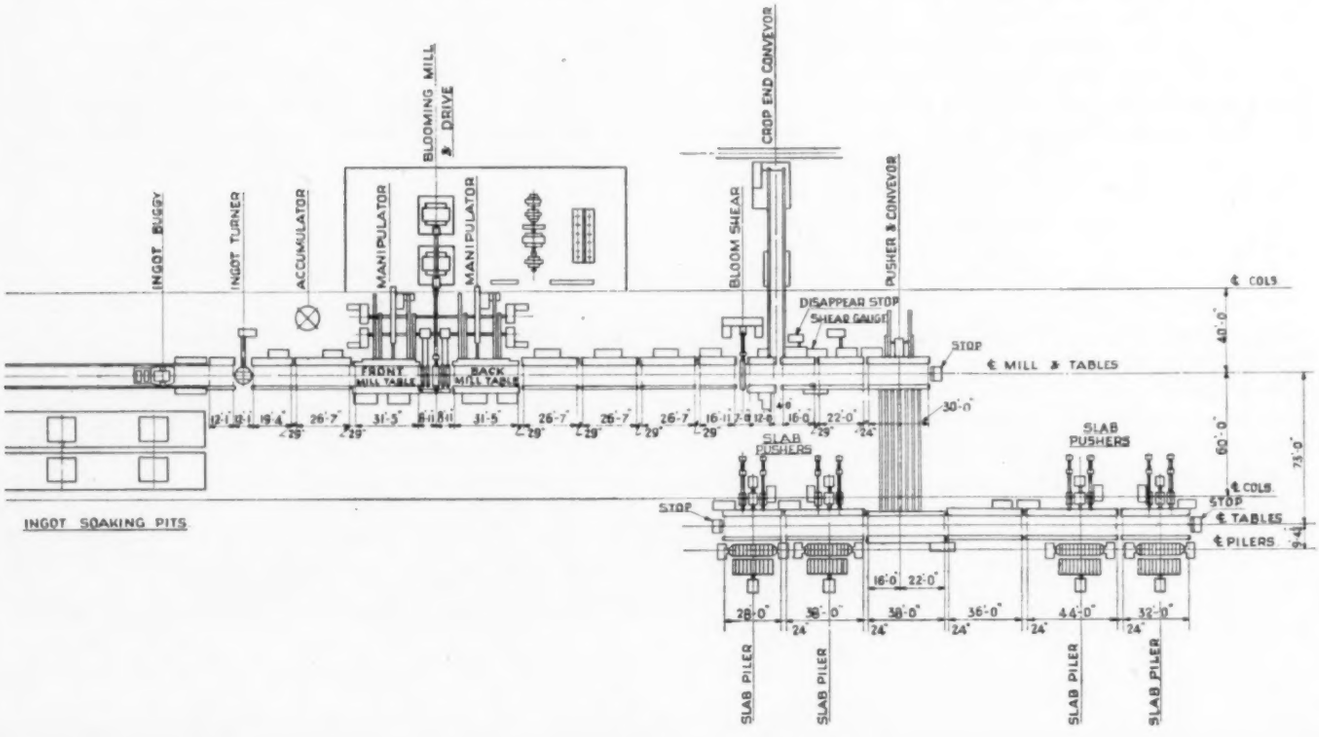


Figure 2 — The principal product of this 40 in. mill is 8 in. x 8 in. blooms, although some small slabs are also rolled. Product may be removed over the transfer or may proceed straight on to a continuous billet mill for rerolling.

Figure 3 — This 45 in. mill is equipped with integral edging rolls and is designed primarily for large production of slabs only.



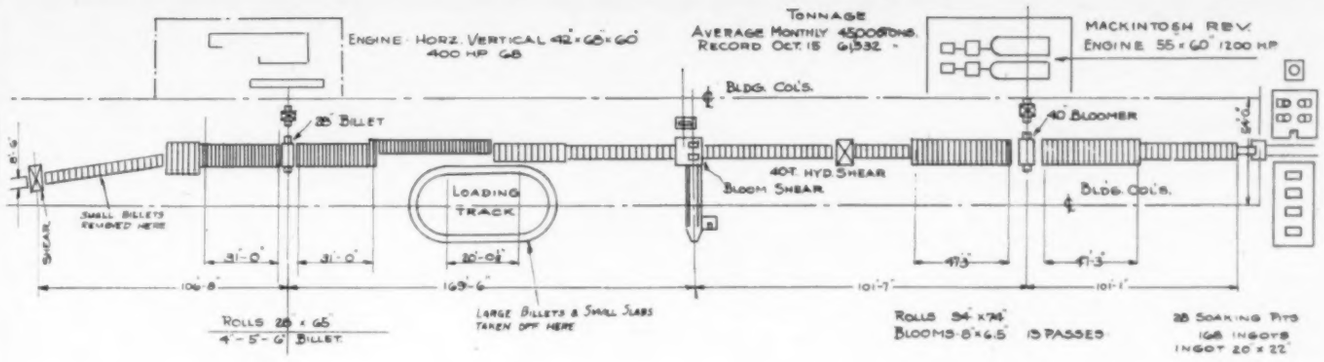


Figure 4 — Typical blooming mill producing blooms and small slabs, which are removed direct by means of loading track. Small billets are produced by further rolling in the three-high stand.

Figure 5 — In this layout, the blooming mill feeds into a billet mill or a strip mill. Slabs for the strip mill may go directly through the strip mill or they may be removed for conditioning and reheating.

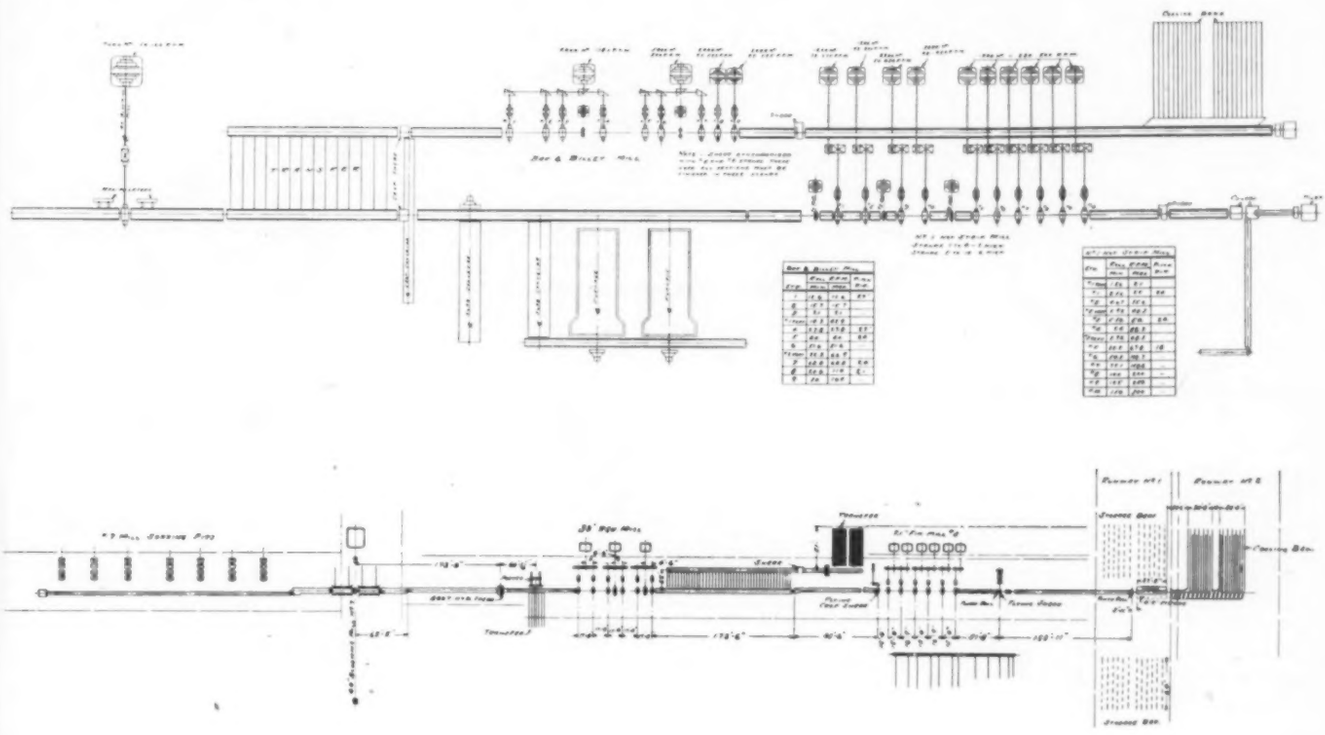
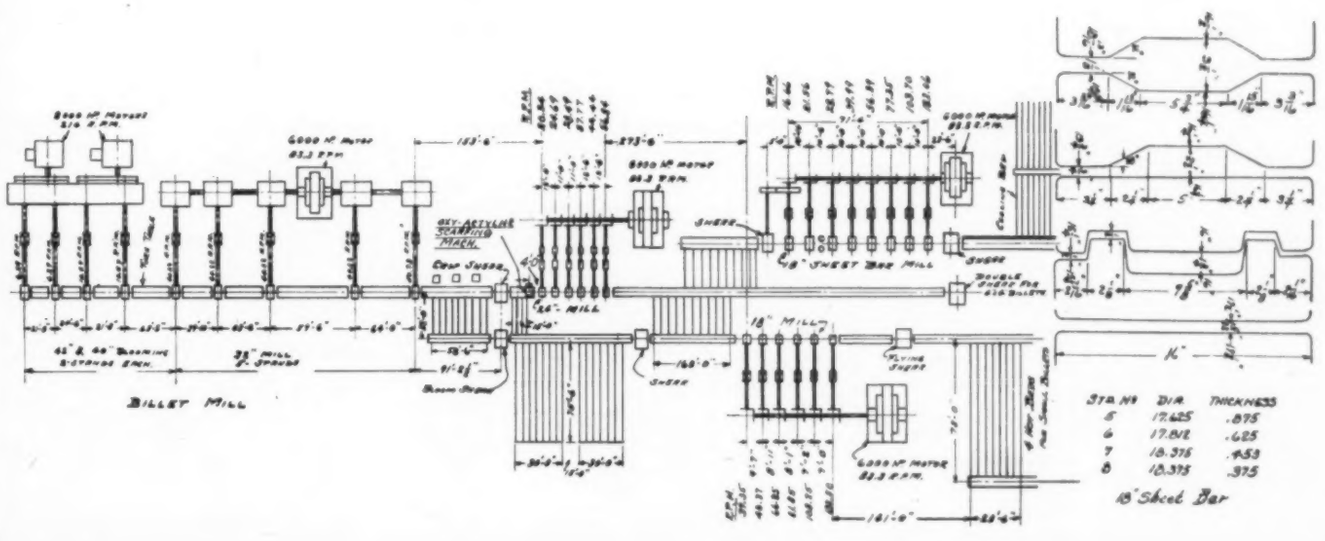


Figure 6 — Blooming mill in direct line with continuous roughing and finishing trains for billets or sheet bar, but with three discharge points for removing the steel after each successive step in the rolling.

Figure 7 — One of the few continuous blooming mills in existence, this unit presents a flexible finishing arrangement, with several combinations of feeding and removal of product.



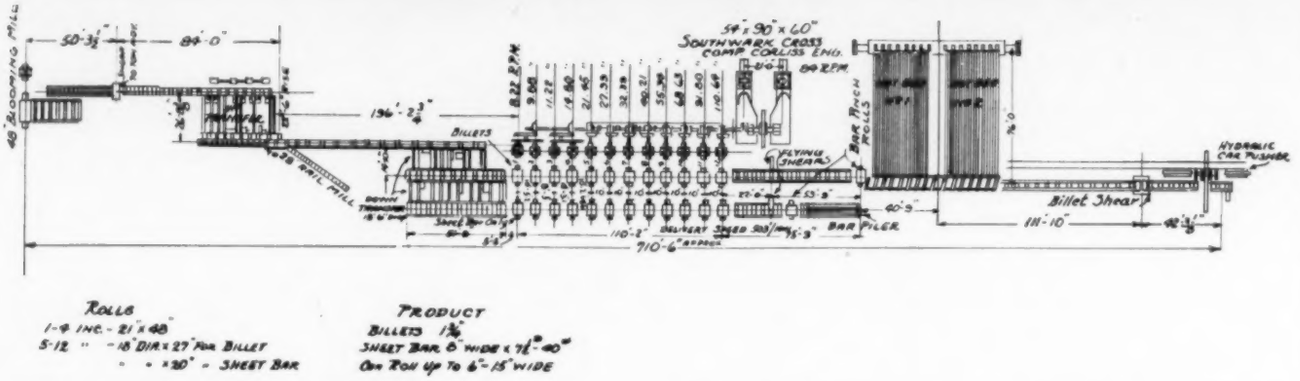


Figure 8 — This blooming mill usually produces 8 in. x 8 in. blooms which pass on through either of two continuous mills hooked together on a common drive.

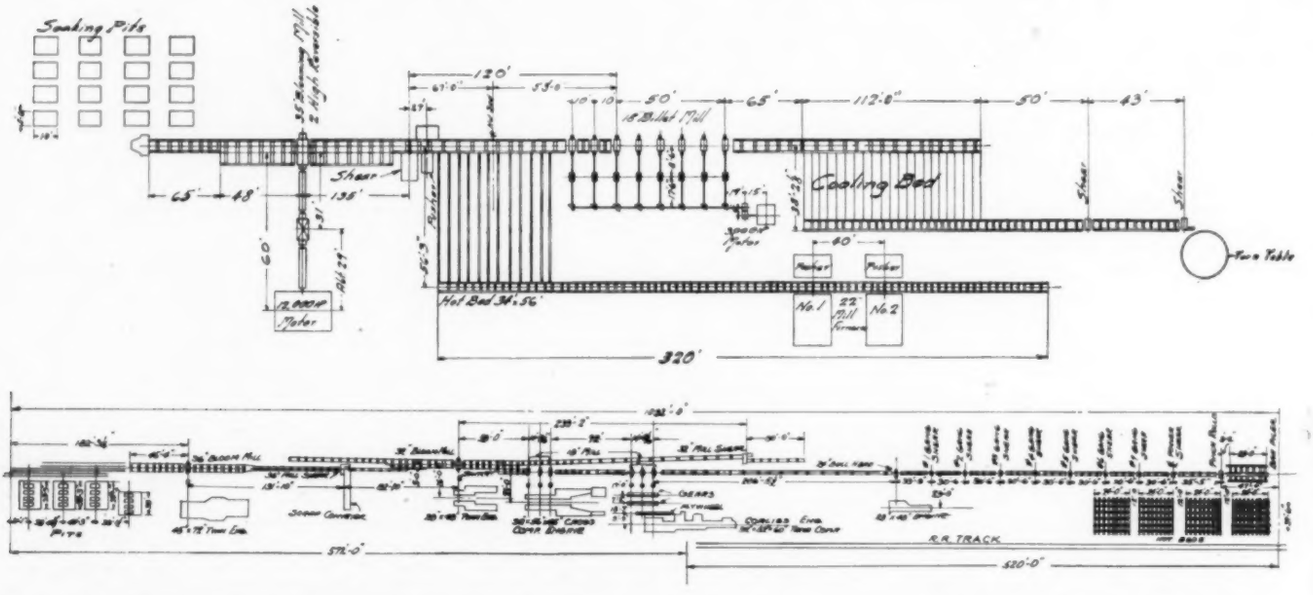


Figure 10 — In this layout, two two-high reversing blooming mills in tandem feed into a continuous sheet bar mill. Blooms may be removed after the 32 in. mill but not after the 36 in. mill.

Figure 11 — This typical three-high bloomer is a 46 in. mill feeding into two 28 in. three-high stands. Small sizes then pass on through the 18 in. continuous billet mill.

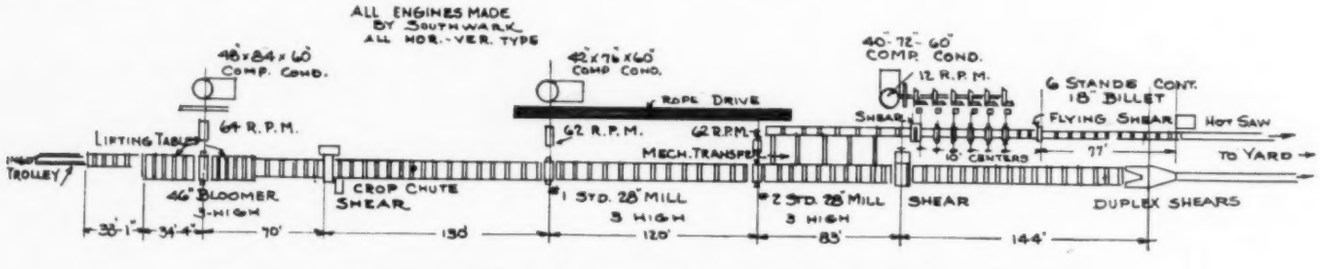
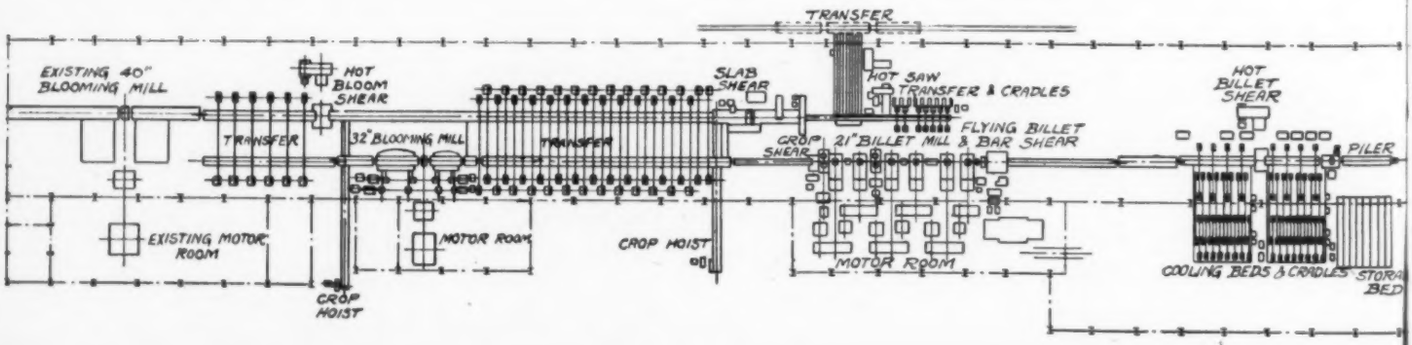


Figure 12 — This combination of 40 in. and 32 in. reversing blooming mills and 21 in. billet mill offers a flexible arrangement for the production of various sizes.



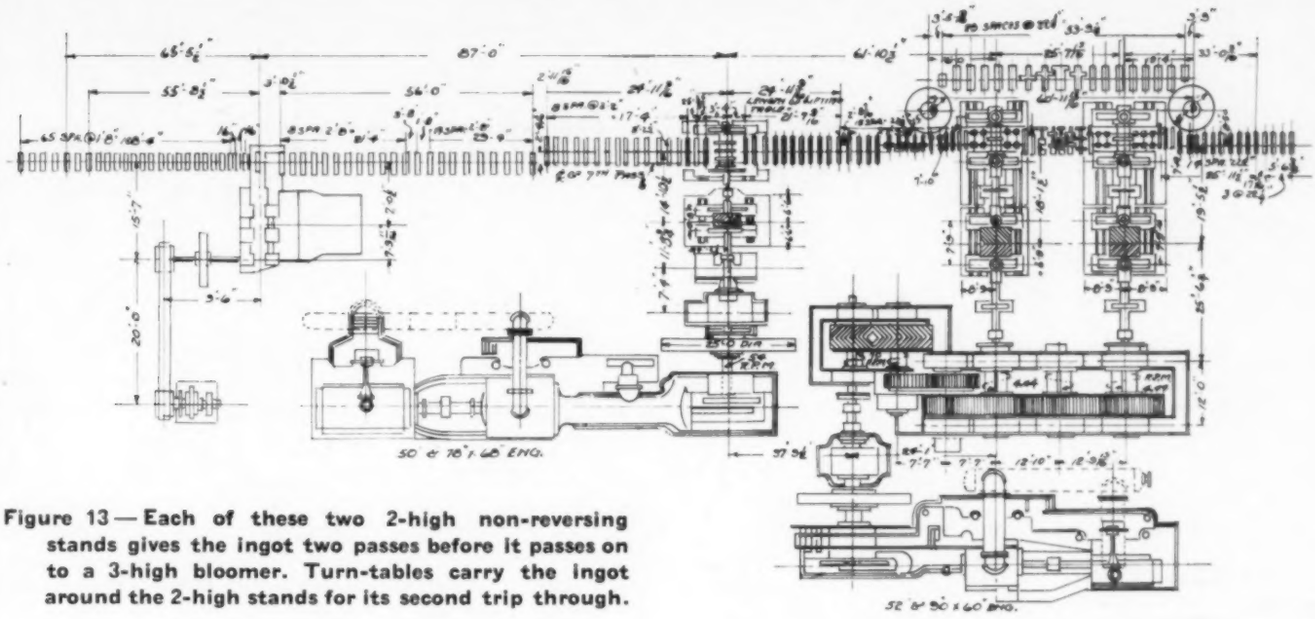


Figure 13 — Each of these two 2-high non-reversing stands gives the ingot two passes before it passes on to a 3-high bloomer. Turn-tables carry the ingot around the 2-high stands for its second trip through.

panying roll pass layouts, passes may be placed obliquely in the rolls, relieving much of the twisting strain.

A very pertinent question is that of having the universal coupling cast integral with the roll, or made separately and keyed on to the roll. As far as we can see, the only advantage possessed by the integral coupling is that of convenience to the user, as when the roll is received, it is ready for turning.

The disadvantages far outweigh the advantages; the roll itself must be made of such a composition as to provide maximum strength in the coupling rather than maximum wear on the roll itself and that is an extremely important point. Integral coupling rolls require possibly two weeks machine time and an expense of $500 to $1000 per set of rolls and the deliveries are correspondingly longer.

Rolls with the keyed-on couplings have a somewhat higher cost for the first set of rolls, but the renewal cost of the rolls without the couplings is much lower. Here the coupling itself can be made of tough, shock resisting steel and is reusable many times. The roll can be made of the most suitable composition and unrestricted by the requirements of the wabbler. In order to change the existing rolls, the present spindle must be shortened by some 12 to 20 inches, and this is entirely feasable in most cases.

The rolls for bloom and billet mills are among the most simple of the roll applications that are met in the trade. They are the ones upon which the most exact service records are obtainable because the work that they are called upon to perform is fairly constant with the tonnage produced per diameter reduction, a good criterion of the value of the rolls themselves.

It is almost an axiom in the trade that the hardness of a roll be held to a maximum, still maintaining sufficient strength to avoid breakage and just under that hardness which would cause slippage. The hardness is principally controlled by the carbon content, aided and

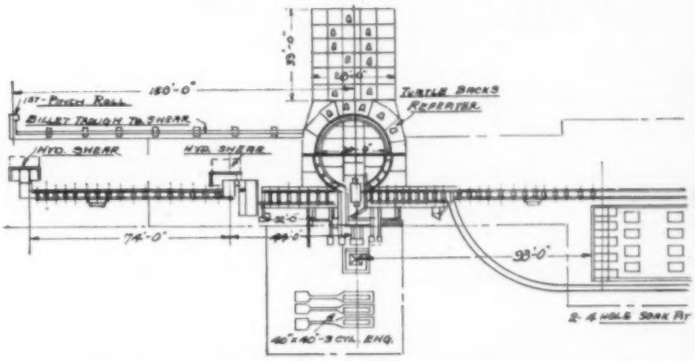
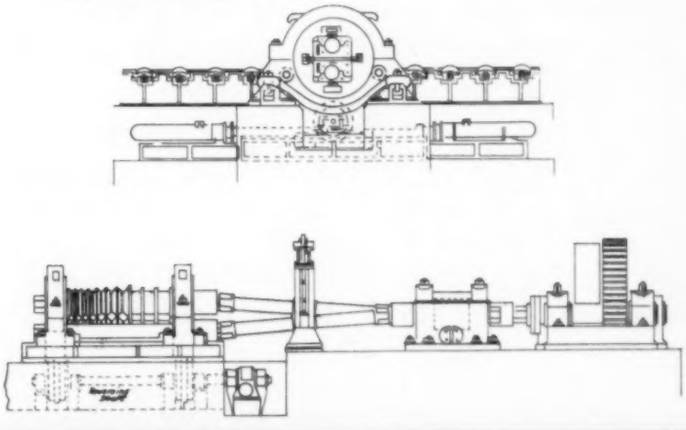


Figure 14 — In this mill, the ingot is given a number of passes back and forth and when reduced sufficiently is led around the housing by a repeater for successive passes while the mill runs in one direction. It is an attempt to combine the blooming and billet rolling operations in one mill.

Figure 15 — Another plan to avoid a reversing drive is the Lamberton mill, of which there is only one in the United States. It consists of two rolls mounted in a housing which rotates through 180 degrees, thus reversing the direction of rolling while the drive runs only in one direction.



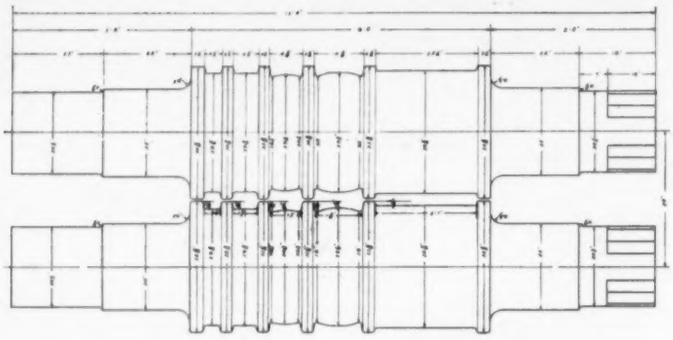


Figure 16 — Roll for 40 in. blooming mill shown in Figure 4 which can be used down to 4 in. x 4 in. The 4 in. pass, however, is usually used only for edging.

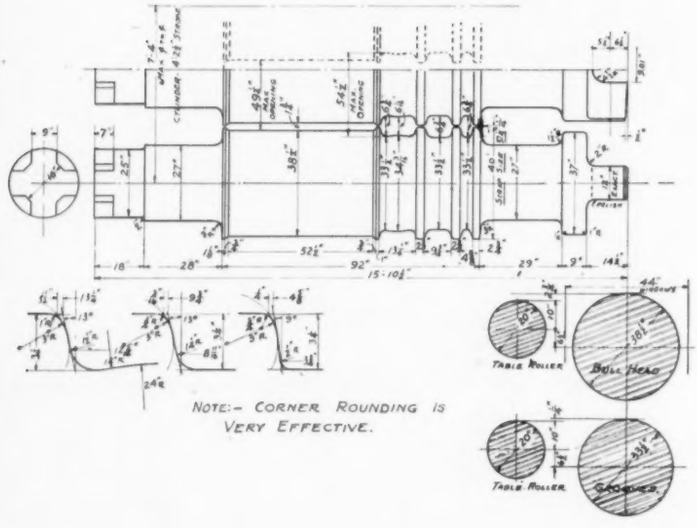
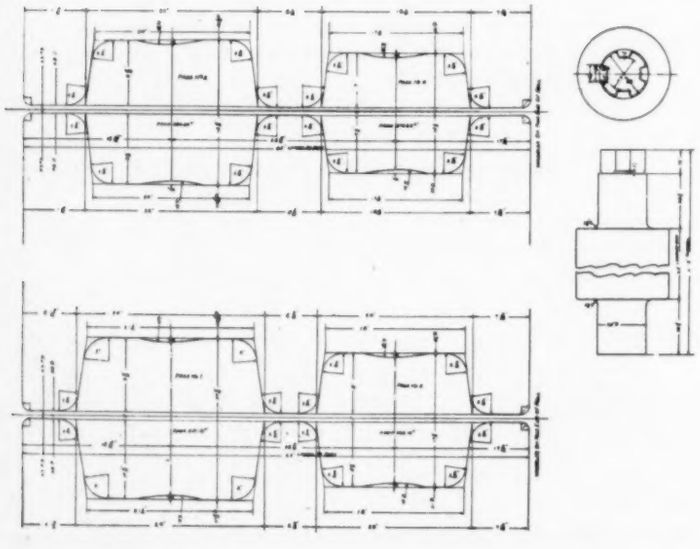


Figure 17 — Roll used on 46 in. blooming mill to produce 8 in. x 8 in. or 6 in. x 6 in. blooms or slabs up to 50 in. wide.

Figure 18 — These passes are used in the two-stand non-reversing mill previously shown in Figure 13 for the first four passes on the ingot, which then proceeds to a three-high mill.



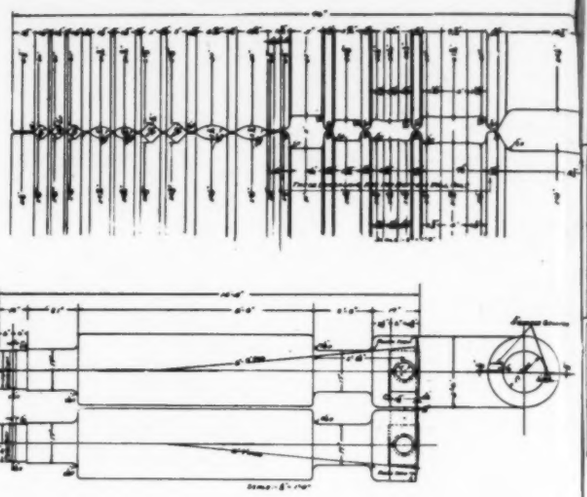


Figure 19 — This type of roll is used in the single stand combination of blooming mill and billet mill shown in Figure 14.

Figure 20 — This roll carries a diamond 4 in. pass so that the 40 in. mill can roll a considerable quantity of 4 in. squares. This allows this pass to be dressed without undue reduction in roll diameter.

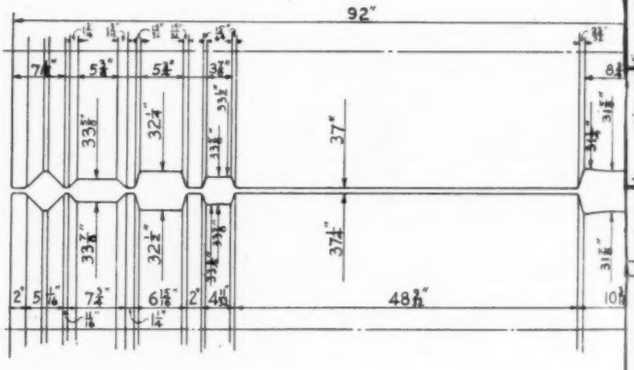
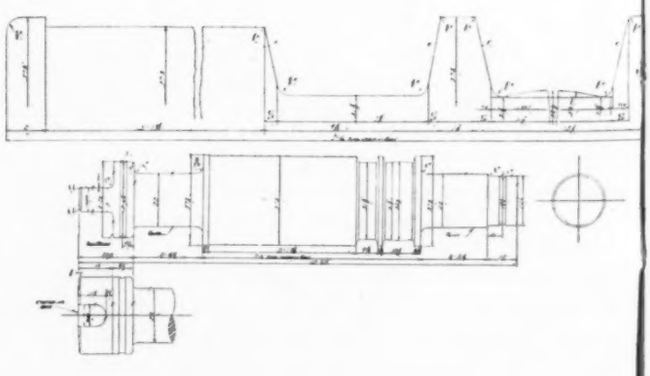


Figure 21 — This roll is used in the 44 in. reversing mill which is credited with the record tonnage, up to 170,000 tons per month. The mill rolls slabs and blooms.



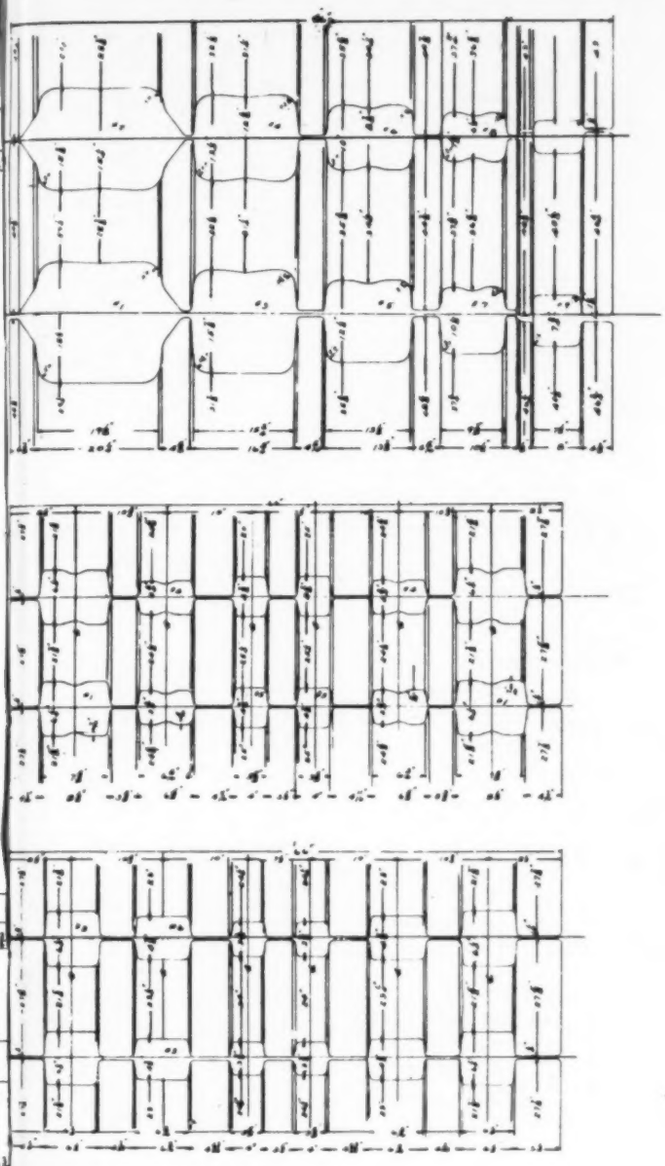


Figure 22 — Showing the design of rolls for a three-high bloomer and for two three-high billet mills following it.

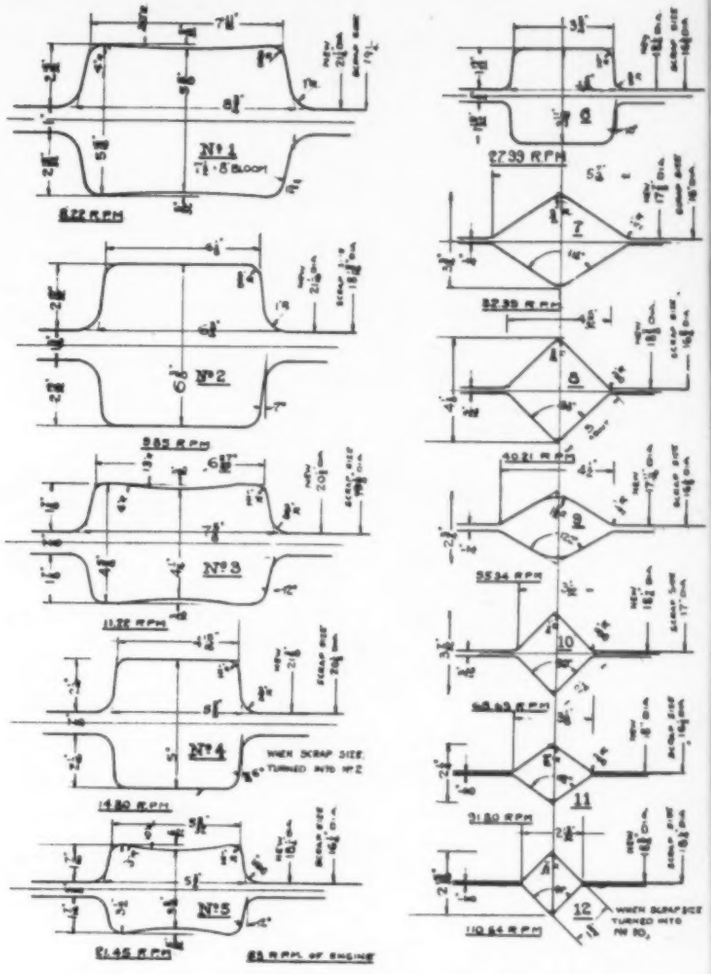


Figure 23 — Typical pass design in 18 in. continuous billet mill for 1¾ in. squares. The flat 4 in. pass has since been changed to diagonal.

abetted by the judicious use of alloying elements, together with heat treatment. The principle alloying elements are nickel, molybdenum, chromium and boron. Blooming and slabbing mill rolls usually have a carbon content from .50 to 1 per cent but some special rolls require even lower carbon while others permit the use of up to 2 per cent carbon.

The rolls for billet mills vary from .80 carbon alloy steel up to grain rolls, depending upon the work they are called upon to perform.

The main difficulties in the use of blooming mill rolls are fire-cracking, excessive side wear on the collar, slippage, steam cutting, breakage, or holes and streaks of segregation. Any one of the above difficulties opens up a controversial field, each extensive enough to provide a complete meeting discussion. The holes and streaks in the rolls are put last as they are purely a foundry problem.

Fire-cracking is a joint problem, as a roll that has been made with an injudicious use of alloys and improper heat treatment is very liable to fire-crack, while on the other side most perfectly made rolls can be fire-cracked through mill abuse. A mill accident of a sticker can start a fire-crack and often a start is all that is necessary for a crack to grow to dangerous depth. The injudicious use of water is also conducive to the formation of fire-cracks. A large flood of cold water upon the heated surface of the roll can cause such sudden contraction, one that is beyond the ability of the steel to resist, and cause incipient cracks. Many operators believe in and practice the use of moderately warm cooling water.

The rolls of today are a high quality product, as dissimilar to the rolls of yesterday as the race horse is to the plug. As such, they are susceptible to abuse but given the proper care they produce record tonnages with a resistance to fire-cracking which was formerly

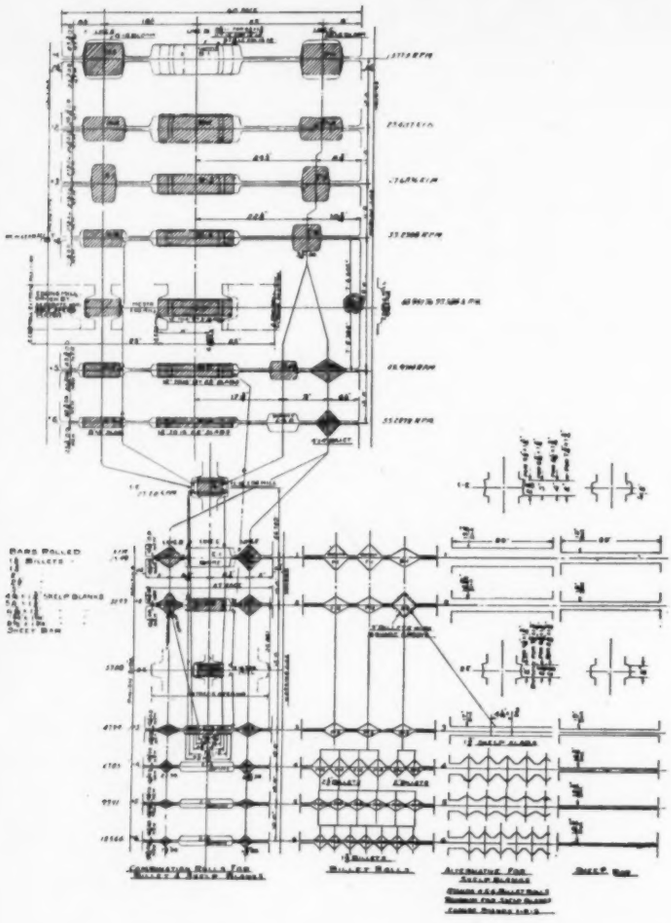


Figure 24 — This pass layout in 24 in. and 18 in. mill rolls for producing billets, sheet bar and small slabs for skelp is a very flexible combination.

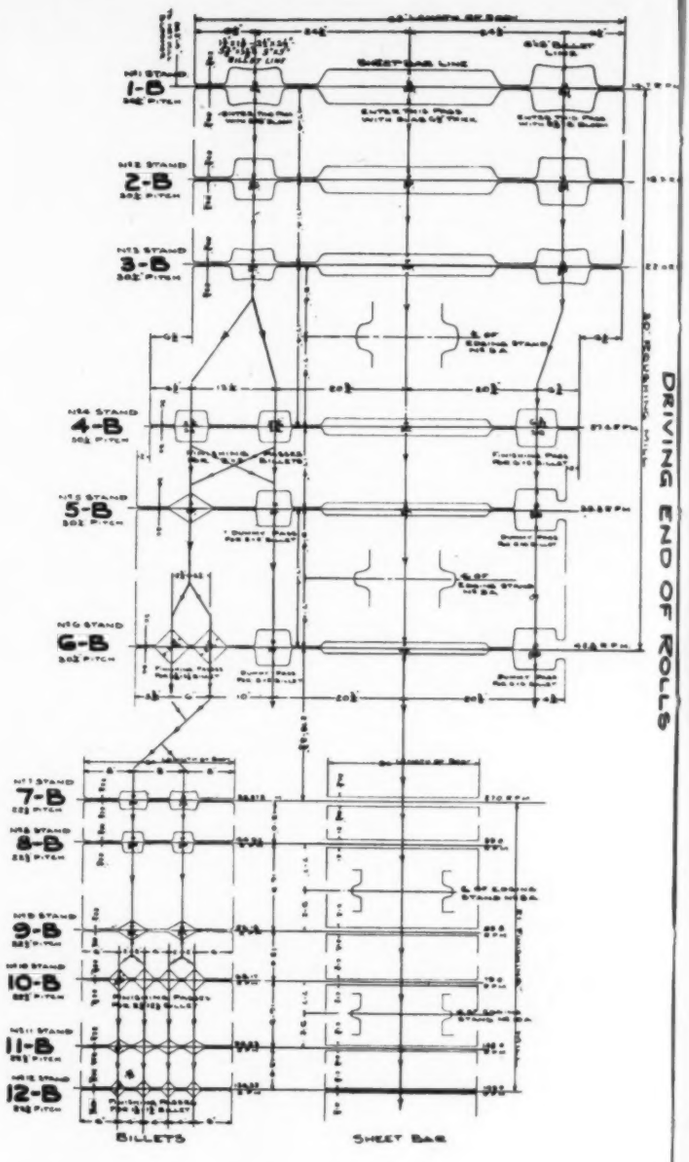


Figure 25 — Mill layout for rolls for producing billets, sheet bar or slabs.

believed to be an unsurmountable inherent quality of steel used for hot forming under pressure.

The side wear on the passes of rolls has been largely reduced by special heat treatment in which the sides of the passes are maintained from 4 to 6 points Scleroscope harder than that of the main body of the roll.

Slippage is largely a matter of hardness combined with that of the percentage of draft used and the kind of steel being rolled. This is a special consideration for almost each and every mill and is often accentuated by the fact that the pitch diameter of the rolls may have been increased from time to time, thus bringing the pitch line of the mill substantially above the line of the tables and causing the piece to enter the rolls at an angle, and thus reducing the area presented to the rolls for their bite.

Breakage is an infrequent occurrence and may be due to excessive hardness of the roll, a defective casting, or a mill accident.

Steam cutting of the passes is sometimes encountered and is generally believed to be entirely a mill problem.

The modern slabbing mills are mainly called upon to produce stock for the continuous hot strip mills demanding a product with a smooth clean surface. Therefore, the rolls cannot show much surface roughness or any substantial amount of fire-cracking. The rolls usually contain a moderate carbon content plus 1½ per cent nickel and about ¼ per cent molybdenum with a minimum of chromium. They are heat treated to the maximum hardness possible without encountering slippage. The optimum hardness has been found to be about 38 Scleroscope but in some mills it must be kept as low as 34, where others can use up to 44.

Blooming mill rolls having edging and bloom finishing passes present a somewhat different problem in that they also encounter side wear and under-cutting of the passes. Rolls of about the same composition as that of slab mill rolls are most successful but heat treated so that the collars and sides of the passes are considerably

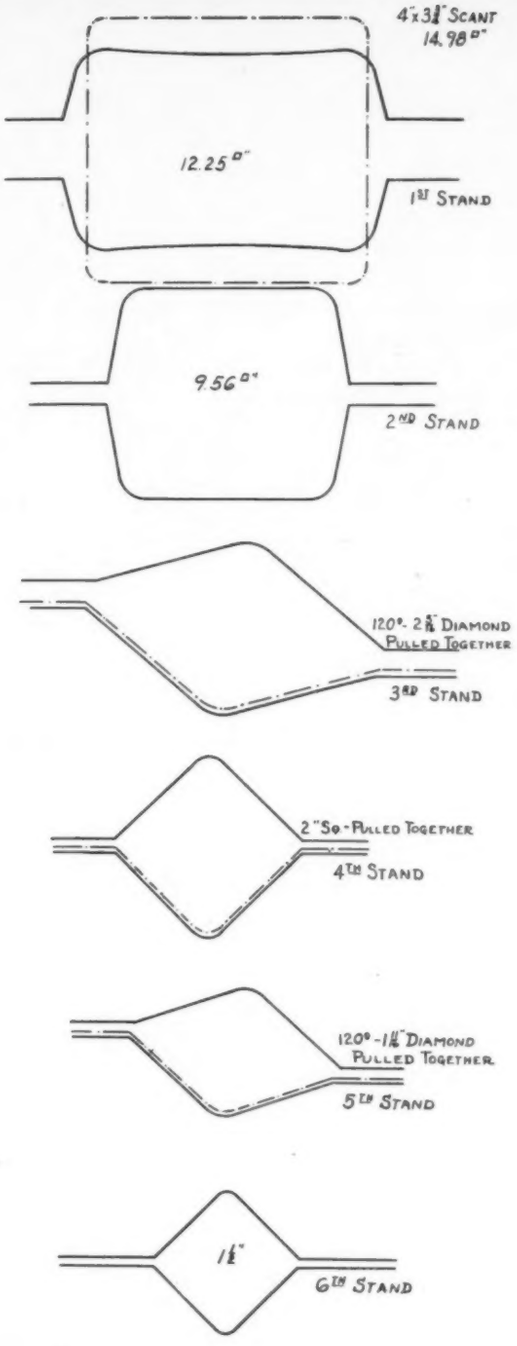


Figure 26 — Billet mill passes with diamond pass cocked on an angle of about 120 degrees. This automatically helps to twist the bar, offsetting the tendency of twist guides to open up seams.

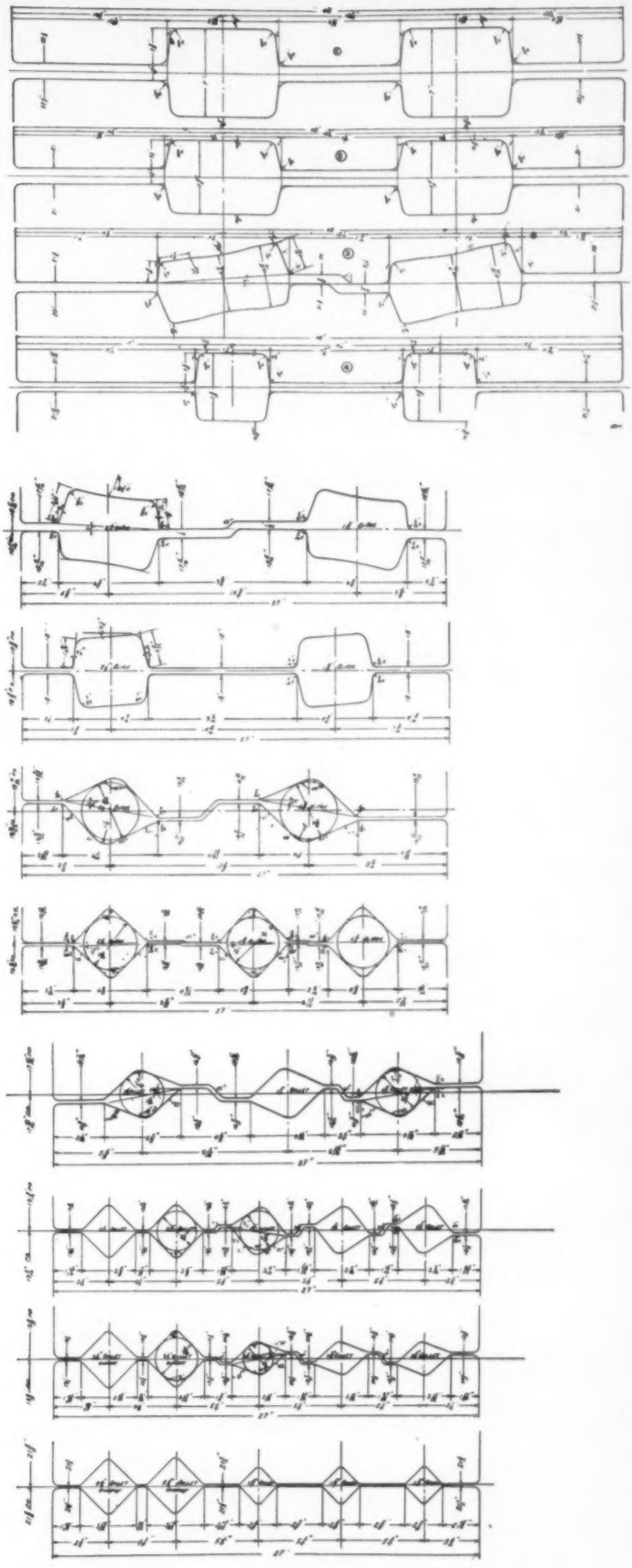


Figure 27 — In this series of passes, the box passes are placed on an angle which helps to turn the bar and relieve guide pressure on the billet. This layout is very successful in eliminating the opening of the seams.

harder than the rest of the roll and thus bring additional resistance to side wear.

The same conditions also apply to the rolls for the special mill layouts. The second mill of the double mill system may be considered more in the light of a two-high reversing billet mill and is treated accordingly.

The standard continuous billet mill is usually supplied with rolls for the roughing stand of 1.80 carbon alloy steel at 40/42 Scleroscope hardness. The first

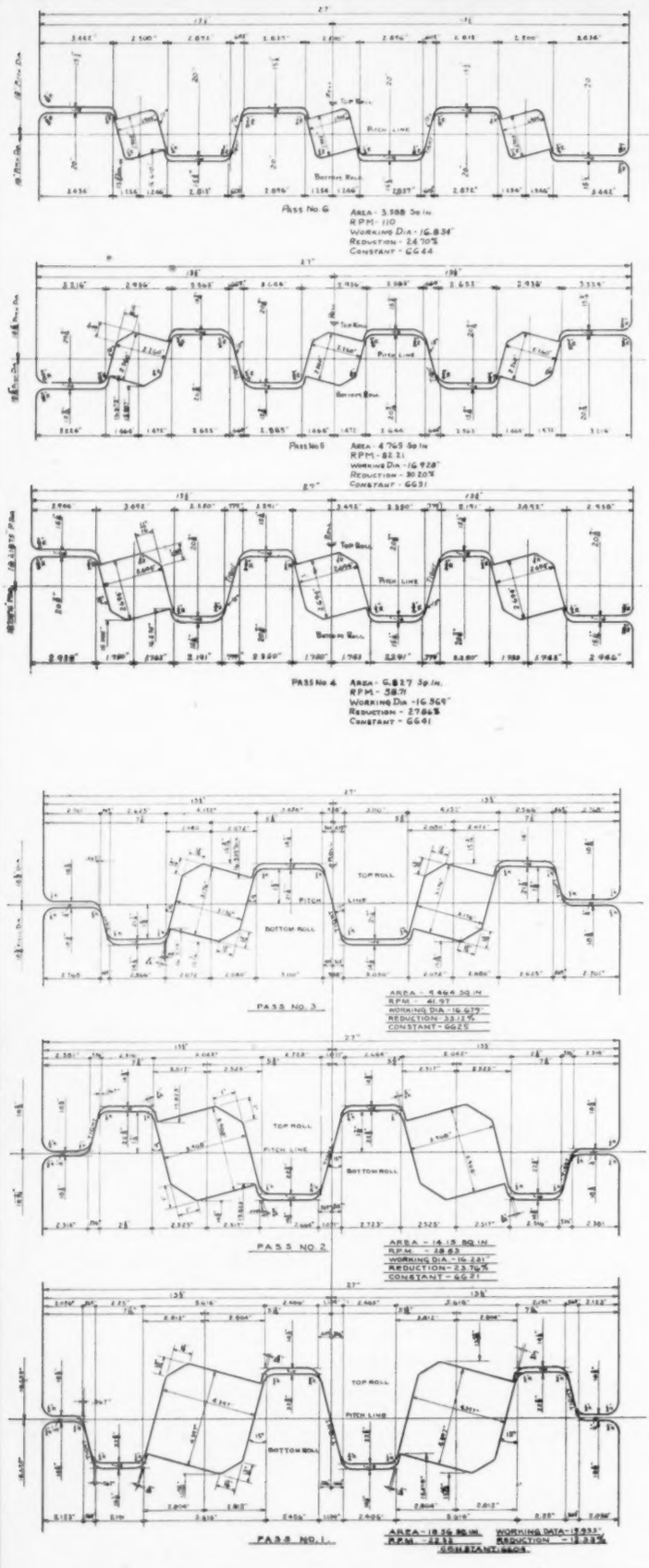


Figure 28 — In this layout, all passes have been placed on the oblique. Thus, the bar is twisted only 15 degrees one way to 15 degrees the other way, and pressure is applied on all sides of the billet. The method results in considerable end thrust on the roll.

three stands of the finishing mill are of the same composition and the last three stands are of a grain roll at 65/70 Scleroscope with a good depth penetration of the hardness. Some mills have found a lower carbon, nickel alloy steel heat treated to 42 Scleroscope more successful than the higher carbon rolls for the roughing mill and the first three stands of the finishing mill. Some special designs cause excessive stress on the rolls of some particular stand and the above procedure is modified accordingly.

Two-high and three-high billet mill rolls require the same considerations as blooming mill rolls. The carbon content is often higher and is controlled to produce the optimum hardness.

In conclusion we want to point out a fact that we have continually touched upon — rather harped upon — for many years. That is the advantages that accrue to the rolling mill operator who most closely cooperates with the roll manufacturer through their accredited representatives. All roll manufacturers make good rolls but it is those who most exactly supply the proper grade of roll for the specific job at hand who are most successful. They are able to furnish the rolls to meet the specific conditions and produce the most tonnage for a given roll cost when they most exactly know the conditions to be met.

DISCUSSION

PRESENTED BY

RALPH WRIGHT, Steel Mill Engineer, Industrial Engineering Department, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania

R. E. BEYNON, Roll Engineer, Carnegie-Illinois Steel Corporation, Chicago, Illinois

F. C. T. DANIELS, Vice-President, Mackintosh-Hemphill Company, Pittsburgh, Pennsylvania

E. M. D. HEROLD, Roll Designer, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania

D. L. EYNON, Roll Designer, Mackintosh-Hemphill Company, Pittsburgh, Pennsylvania

E. E. BRAYSHAW, Superintendent, Rolling Department, Carnegie-Illinois Steel Corporation, Clairton, Pennsylvania

LOUIS MOSES, Superintendent, Rail Mill and Roll Departments, Bethlehem Steel Company, Sparrows Point, Maryland

Ralph Wright: It may be difficult for an electrical man to make a discussion which will contribute much to such an excellent paper. However, it seems in order to say that electrical engineers and electrical manufacturers are vitally interested in mill layouts as have been shown in this paper. This is, of course, because we endeavor to make the electrical equipment fit the work and the layout. The fine array of mill layouts

given in the paper shows that there are many good arrangements for producing blooms and billets.

The factor which probably has had the greatest effect on mill performance and electric drives is the tendency to specialize. Twenty-five years ago when we sold a reversing blooming mill drive the mill and drive were usually expected to handle anything from 24 in. slabs down to 4 in. x 4 in. blooms. This required high torques at 40 or 50 rpm for rolling slabs. Also it was necessary to reach a speed of around 120 rpm on the long finishing passes in order to roll the required tonnage of 4 in. x 4 in. billets. To meet this wide range of operating conditions many of the old reversing motors operated over a 3 to 1 speed range by field control. This made it difficult to control the reverse power peaks and required careful maintenance of the control and commutators. With such a combination of operating conditions the tonnage naturally was limited as compared to present practice.

The present tendency is to roll heavy sections in the blooming mill and make the final reductions in secondary mills. This increases the tonnage of the blooming mill and gives easier operating conditions for the drive. Reversing equipments are now selected to produce high torques and the speed range is seldom more than 2 to 1. The use of a narrow speed range and the general improvement in design of large d-c machines and control has resulted in a marked reduction in maintenance.

A very interesting exception to the tendency to specialize is a 40 in. blooming mill installed in the South in 1930. This plant had a light steam driven mill used almost exclusively for rolling 4 in. x 4 in. blooms. The mill had a simple and fast hydraulic manipulator; 4 in. x 4 in. blooms were finished in a 90 degree diamond pass. The rapid manipulation and diamond finishing pass made an unusually fast mill and enabled the rollers to establish excellent tonnage records.

Expansion of the plant made it necessary to install a complete new mill which could roll both slabs and 4 in. x 4 in. blooms. A 40 in. mill with a 7000 hp, 50/120 rpm drive was selected. The new mill was expected to produce slabs as required and to supply the regular output of 4 in. x 4 in. blooms. If it had been desired merely to replace the engine on the old mill, a drive rated at 4000 hp at 70/140 rpm would probably have been selected. In order to obtain fast operation with the slower, heavier drive actually selected, it was decided to abandon the old constant voltage control system using contactors and resistors directly in the various field circuits. A new system was used in which each field circuit was supplied by a separate variable voltage exciter. This control system has since become the standard for all reversing mill drives.

Observation of the old mill had inspired a real respect for its ability to turn out 4 in. x 4 in. blooms so it was expected that careful adjustment of the new equipment would be necessary to secure an equal output. The new mill had heavy electric manipulators and screwdown, and square box passes were provided for finishing, all of which gave a tendency to slow operation. After the mill crews had become accustomed to the new mill it became quite evident that mechanical and electrical equipment would have to be set up for high speed operation. The tables, screwdown and manipulator were speeded up and the main drive was adjusted for unusually fast acceleration. As soon as the mill crews learned how to handle the mill with these adjustments they were able to equal and exceed the records established by the old mill. Such a result had not seemed possible when the mill was first operated with approximately normal adjustments.

It has always been a matter of considerable curiosity to us to know what capacity for small blooms would have resulted if the old diamond finishing pass with suitable manipulator had been retained. The use of the diamond finishing pass saved manipulation time in finishing and seems like a clever way to increase output on small blooms.

Most mill operators have at some time used ragging on the rolls to reduce mill chatter on heavy drafts and at high entering speeds. Twin motor drive offers relief from chatter and from marking caused by roll ragging. Experience has shown that mills with twin motor drive are less likely to chatter. The rolls are not rigidly connected through pinions and so can shift slightly in relative angular position at the instant the metal enters the pass. This makes it possible to enter over a wider range of speeds and drafts or to reduce or eliminate roll ragging.

R. E. Beynon: Due to the present shortage of nickel, there is a great deal of molybdenum being used now in alloyed steel rolls, where formerly the rolls were made of chrome-nickel or chrome-nickel-molybdenum steel. I would like to ask whether the chrome-molybdenum roll is as effective for shock resistance as the chrome-nickel or chrome-nickel-molybdenum roll?

F. C. T. Daniels: Mr. Beynon's question was in regard to the use of molybdenum as a substitute for nickel in rolls, particularly in reference to their ability to resist shock. His principle point was on account of the scarcity of nickel. At the present time molybdenum is scarcer than nickel, but to answer the question, I believe that the moly roll has a greater resistance to shock than the nickel roll, particularly if the chromium is kept on the low side and the roll is properly heat treated.

The nickel has a property, I think, of increasing the resistance to fire-cracking, particularly, and where that is a necessity we can substantiate the use of nickel.

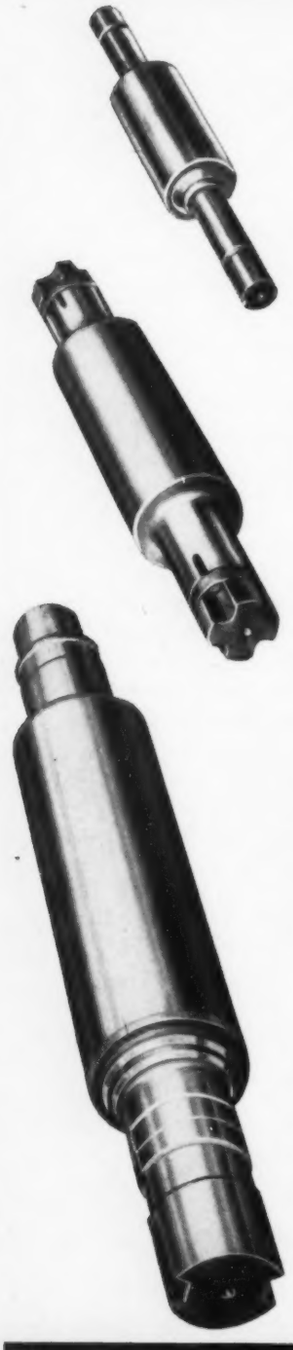
E. M. D. Herold: I would like to ask Mr. Daniels how he determined the angle at which to cut passes to assure getting the correct twist required to turn up into the following stand.

We used this method of twisting on a cross-country mill where we were too short between stands to turn the bar without stopping the mill. It was necessary for us to cut this pass three times before we got the exact twist that we wanted.

I would like to know if Mr. Daniels has a formula that will assure cutting the pass at the correct angle the first time.

D. L. Eynon: The distance between the stands determines the amount of twist that must be given to the bar. The amount of draft on the bar from pass to pass and where the draft is placed must be known. In order to make the bar twist, the draft is increased on one side or the other of the pass, and the amount of the twist is determined by the amount of draft so placed.

A twist guide is used to exert a control and prevent



Reducing INTANGIBLES To Rule

REDUCING roll-making intangibles to facts has formed a legend of many years over which have been crystalized fundamentals and rules that represent collectively a priceless asset to the steel industry.

Successful roll-making demands highly specialized metallurgical talent that only long experience can develop.

Under this observation, as much by instinct as rule, the variables of scrap-mixing, proper heating, timed pouring, and other factors are constantly passing under more positive control.

NATIONAL ROLLS are developed over this careful supervision with the intention of justifying the confidence of those in the mill responsible for tonnage quotas of uniform quality, and we believe they merit this confidence.

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Heavy Iron Castings and Rolling Mill Equipment

AVONMORE, PA.

the bar going over one way or another. It is preferred to have it go over rather than under in order to avoid opening up seams in the bar.

E. E. Brayshaw: I noted that Mr. Daniels spoke of using steel and sand-iron rolls in the billet mill. In our particular setup, which is 28-inch mill, 3-high, we have had some good experience with the modern sand-iron roll. We have found that the passes in the steel rolls wear wide rather rapidly; not so in the sand-iron rolls. Such rolls being of a more graphitic nature, the graphite in the sand-iron rolls seems to act as a lubricant. We found this particularly true when we used a sand-iron middle roll with a steel top and bottom. At the time of dressing, the sand-iron roll passes had to be opened to satisfy the widths of the steel rolls.

F. C. T. Daniels: It is rather an axiom in the roll trade that an iron roll of the same hardness is considerably better wearing than a steel roll, but the important thing in this case is that the iron roll that Mr. Brayshaw talks about is not the sand iron roll of old times. It is not the same roll we made and tried to use in years gone by. It is considerably harder. It is finely grained and there is a considerable depth or penetration of the hardness and therefore a greater usable diameter reduction.

I think that explains Mr. Brayshaw's present usage of sand iron rolls. Such an explanation is needed by those who have in mind the sand iron roll of yesterday rather than the one of today.

Louis Moses: The question always before the roll provider is whether or not the best suited roll material is being utilized. None of us are satisfied that improvements cannot be made. The matter is involved and a lot of angles must be considered. Experience as gained the hard way is entirely too valuable to discount and usually dictates selections. It is usually smart to stick to that grade which gives good results and let well enough alone. But it is also wise to experiment with a limited number of other roll materials spread over the course of the years. This is worthwhile if only as a check up and assurance that the other fellow does not have an edge on us.

As backed by the very best of reasons opinions vary widely with one plant reporting splendid tonnages secured from plain carbon rolls, another preferring the nickel-chromes and still others advocating chrome-molybdenum material. A number of factors will create such a condition with every mill differing in such matters as cooling water applications in kind, volume and pressure; ingot mass handled, bar lengths, groove width wear, ragging practice, product finish and accuracy, etc.

On the two blooming mills at Sparrows Point the most satisfaction is had with chrome-molybdenum because of its ability to withstand breakage and, throughout the life of a set, to meet the overall conditions on these particular mills. On the other hand, and as illustrating the varied conditions affecting roll performance on prime units, nickel-chrome is preferred on the slabbing mill where its wear resistance is superior to chrome-molybdenum.

There is little difference in the developed fire-cracking patterns of the two materials. Using nickel-chrome rolls in the bloomers, as made by a number of makers,

an additional fatigue cracking developed in which the cracking would run half way, or completely around, the circumference of the bull head pass. With penetration ever growing deeper on successive runs the roll broke. With millions of tons rolled in ten years or more of chrome-molybdenum usage this characteristic did not develop and there was no breakage.

An ideal roll material would develop closely spaced patterns similar to grain leather as contrasted to an undesirable and widely spaced arrangement with wide checkers. The embossing of either of these, within limits and while not desirable, causes no difficulty. An exception lies in the supplementary checks forming within the pattern of the original large ones. When these are at the corners of the original pattern, chunks will break away on account of metal embrittlement. Embossings from such holes in the roll face are damaging to the rolled steel. Heavy dressings are required to restore a workable surface.

Accurate recordings on roll performance are essential with the mill's interest enlisted in rendering accurate reports. There is no economy in limiting roll shop clerical help or in neglecting for too long a review of roll performance. It has occurred that too hasty a conclusion will cause a fixed opinion to be formed on a new material as well as on the old ones, with chastened correction due when a final summing up is made.

Mr. Daniel's recommendation on detachable couplings is well taken from a foundry standpoint. It is indeed a most difficult matter to metallurgically straddle the two requirements of body wear resistance and the shock resisting properties of the drivers. But mills already equipped with rolls having the couplings cast integral cannot always adopt detached couplings because the necessary length of the keyed-on sleeve shortens spindle lengths. As between the spade type and the jaw construction the spade appears to most readily adapt itself to a desired body material. Jaw couplings offer more of a problem in prevention of spreading, the latter not a factor with spades.

I would like to comment on Mr. Daniel's remarks concerning the effects of twist manipulations on continuous mills. Tremendous tonnages of the finest billets are daily produced on such mills. His position is well taken where ordinary twist guide construction is used when care must be taken to prevent scratching under the pressures required to induce twisting. However, the use of sturdy roller twist guides, particularly at the delivery side and sometimes on the entering side of the stand, eliminates most if not all of such trouble and proves that the action of twisting well processed steel is not in itself detrimental.

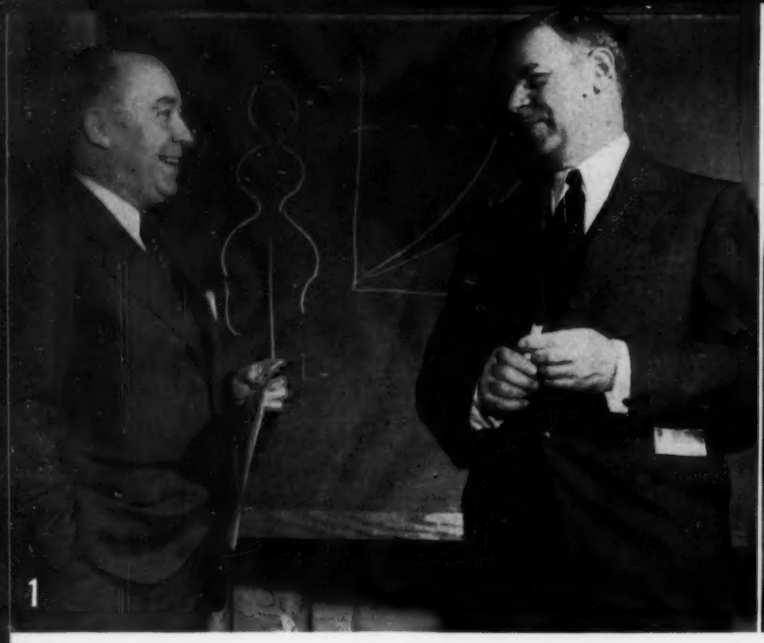
F. C. T. Daniels: I agree quite thoroughly with Mr. Moses, and wish to compliment him on the manner in which he keeps his roll service records. It brings out the point that we tried to stress in the last part of our paper, that cooperation with the roll manufacturer is the best way to obtain the best rolls to use for each specific job. Those who keep the best roll service records are in the best positions to do that.

The fact that Mr. Moses — and it cannot be contradicted — obtains better results from his molybdenum rolls than he does from nickel-molybdenum-chromium rolls I think is due to the type of installation and its operating conditions. That does not mean that the same fact would prevail in a mill of the same size in another plant where the steel is different, the heating conditions are different and the mill crews have different ways of operating. In the trade in general, the nickel rolls are showing a superiority over the molybdenum-chromium in their resistance to fire-cracking. It seems to me, as I recall, that many of Mr. Moses' blooming mill rolls contained a minimum amount of chromium and were more on the molybdenum-manganese type.

Much of the susceptibility to fire-cracking of steel rolls is perhaps brought about because of a foreign gas content in the rolls themselves. This is a subject that is to be thoroughly investigated by the Acid Open Hearth Research Association.

My experience is that the nickel does have a greater effect in the elimination of fire-cracking than molybdenum.

In regard to the universal couplings, keyed on or cast integral with the roll, I recall that at Bethlehem, when they built a new blooming mill for Lackawanna, the rolls were originally designed with integral couplings, and the foundry took it up with the engineering department and persuaded them to use keyed-on couplings and I know that mill is very successful in operation. On a conversion job the spindle need only be at least twenty inches shorter than the present spindle and most of the mills have sufficient room to permit that.



A. I. S. E. Holds Second Rolling M

The second meeting of the Rolling Mill Committee of the Association of Iron and Steel Engineers was held in Pittsburgh, May 8th. The program consisted of two technical sessions, followed by a dinner. At the morning session, at which J. L. Miller, Republic Steel Corporation, and Louis Moses, Bethlehem Steel Corporation, (1) acted as chairmen, papers were presented by B. M. Putich, A. M. Byers Company and J. L. McHugh, Jones and Laughlin Steel Corporation (2). The afternoon session included papers by C. P. Hammond and A. M. Cameron, Atlas Steels, Ltd., (4), by Dr. F. H. Allison, United Engineering and Foundry Company, and by W. B. Snyder, General Electric Company, who is shown (3) with T. B. McElray, Carnegie-Illinois Steel Corporation, who was chairman of the session. Mr. McElray was assisted by J. B. Mitchell, Jones and Laughlin Steel Corporation.

In the absence of C. L. McGranahan, A. I. S. E. president, Mr. Miller, first vice-president, acted as toastmaster at the dinner, at which the

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RAY KLINE PHOTOS

Mill Meeting

8

speakers were Milton Bacon and Philip Whitcomb. (5) Mr. Whitcomb, a foreign correspondent for 30 years, was recently repatriated from internment in Germany, and gave many facts concerning the German army, industry, and morale not set forth in our public news media.

Among the 800 attending the meeting were J. D. Jones, Youngstown Sheet and Tube Company, F. H. Dyke, W. H. Warren and J. H. McElhinney, of Wheeling Steel Corporation (6); A. J. Hulse, Carnegie-Illinois Steel Corporation, E. W. Auer, Republic Steel Corporation, and A. H. Griffiths, Sheffield Steel Corporation (7); P. T. Reynolds, Republic Steel Corporation and F. A. Horn, Youngstown Sheet and Tube Company (8); C. C. Wales, Jones and Laughlin Steel Corporation, F. E. Flynn, Republic Steel Corporation, and J. D. Donovan, Arthur G. McKee Company (9); J. S. Archer, J. L. Hutton, J. E. Miller and F. Mohler, of General Electric Company, G. N. Harmon, Republic Steel Corporation and H. G. R. Bennett, Carnegie-Illinois Steel Corporation (10).

9

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This Bowser Proportioner blends the many different grades of oil produced by this oil company . . . and works with almost unbelievable speed and accuracy. Speed? It blends up to 175 gallons a minute (which is in excess of the rating specified by Wolf's Head). Accuracy? Some of the proportions call for a single pint of one ingredient to 100 gallons of finished blend . . . one part in 800 . . . yet every test is "right on the nose."

The superior performance of Bowser Liquid Control is a familiar story to men in the steel industry, for Bowser equipment is standard in over 90 per cent of American mills for the lubrication of mill stands, pinion gear sets, reduction gears, turbines, turbo blowers and pumps, as well as for coolant filtration and circulation, the filtration of air conditioning system solutions, the metering of fuel oil, etc.

The soundness of Bowser designing and the precision of Bowser manufacturing is only part of the story. Possibly even more important is the fact that Bowser engineers each mill installation for its exact requirements. Bearing sizes and pressures, heats, etc., are all factors in designing the Bowser units, which become integral parts of the mill construction.

Here's another reason why Bowser dominates—wherever your installation may be, there's a complete Bowser service organization conveniently close. BOWSER, INC., Fort Wayne 5, Ind.

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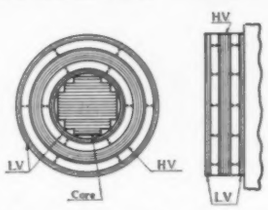

The turns in a circular coil are wound tightly with a safe uniform tension throughout the length of the wire. This eliminates the possibility of stretching the wire and injuring the insulation. The circular shape protects the coil against deformation due to radial short circuit forces. Tendency for vertical movement in the windings is eliminated by balancing the primary and secondary windings of the coil in the axial direction.

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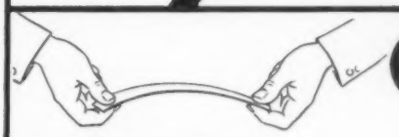

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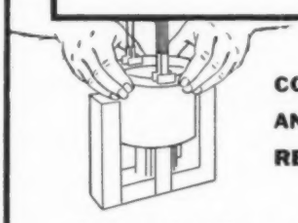

COIL EASILY AND QUICKLY REMOVED FROM CORE

Core and coils are not impregnated as a unit. The coil can be removed from the core by a simple operation — loosening two bolts and removing the top yoke laminations. All this can be done in a very few minutes with perfect safety to core and coils.

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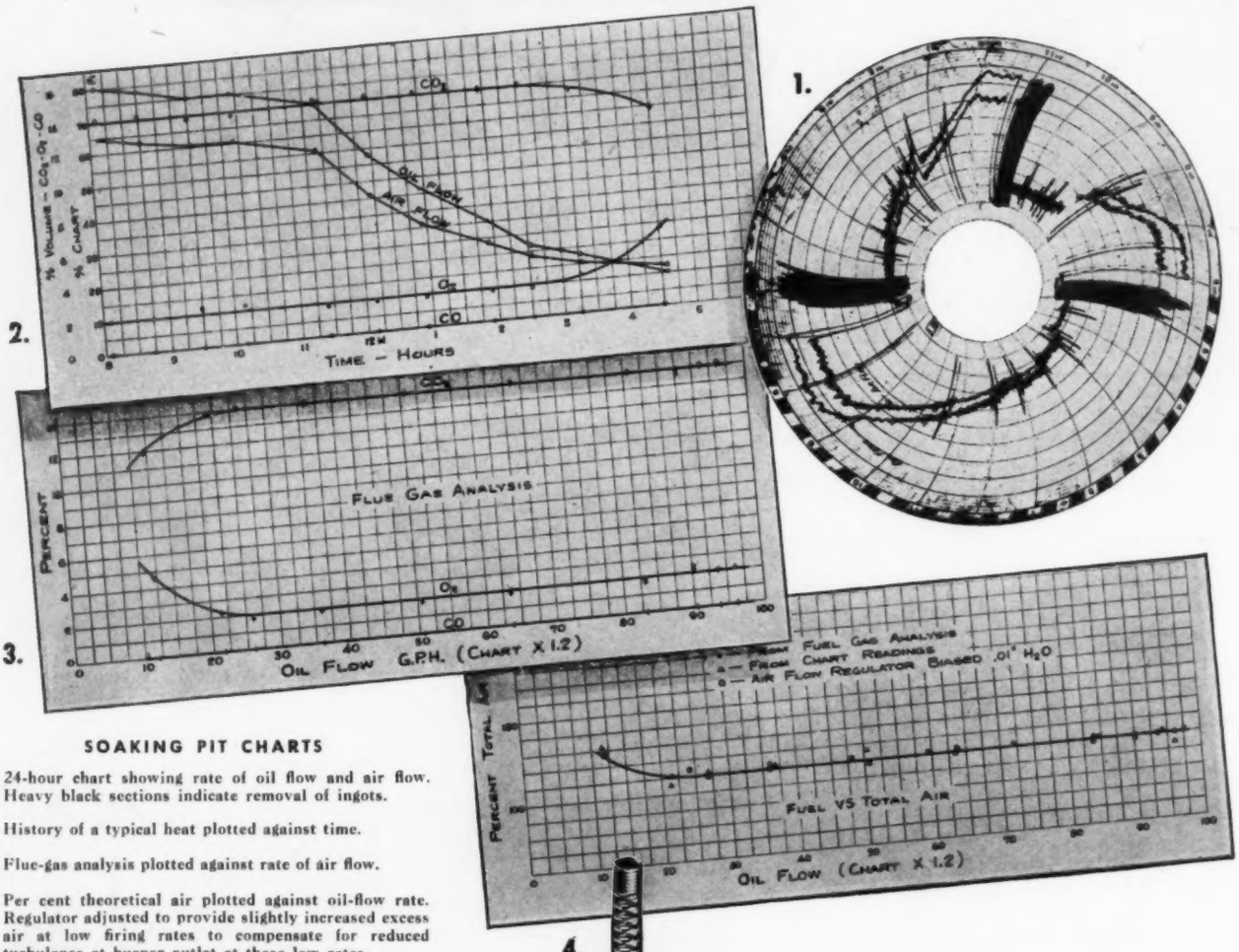
Hagan controlled oil-fired soaking pits

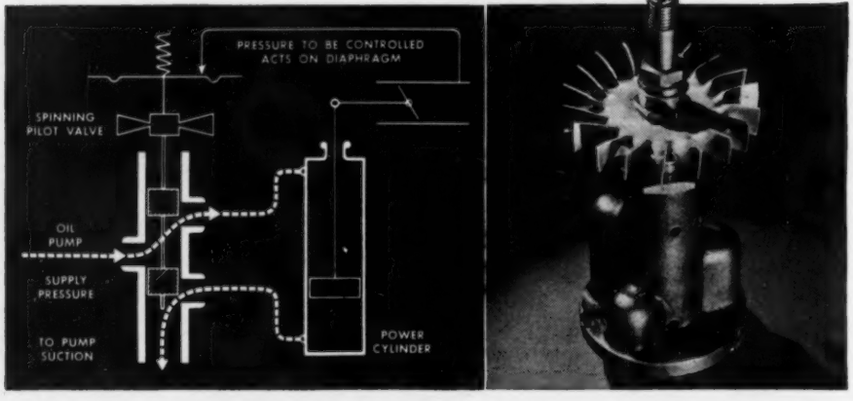
—the combustion story in a nutshell



SOAKING PIT CHARTS

1. 24-hour chart showing rate of oil flow and air flow. Heavy black sections indicate removal of ingots.
2. History of a typical heat plotted against time.
3. Flue-gas analysis plotted against rate of air flow.
4. Per cent theoretical air plotted against oil-flow rate. Regulator adjusted to provide slightly increased excess air at low firing rates to compensate for reduced turbulence at burner outlet at these low rates.

Hagan Spinning Pilot Valve



THE maintenance of fuel-air ratio in an oil-fired furnace places exacting demands on the oil measurement and the fuel-air ratio control apparatus.

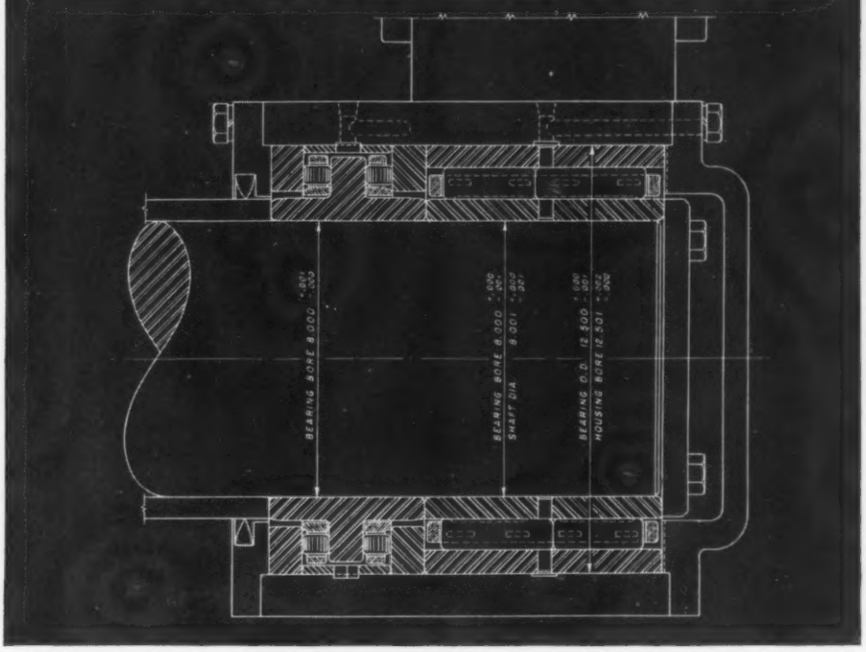
Hagan engineers have developed a method so precise that an extremely constant ratio can be maintained over a wide operating range. In addition, the characteristics of the maintained ratio itself can be controlled to compensate for unusual operating conditions.

HAGAN CORPORATION · HAGAN BUILDING · PITTSBURGH 30, PA.

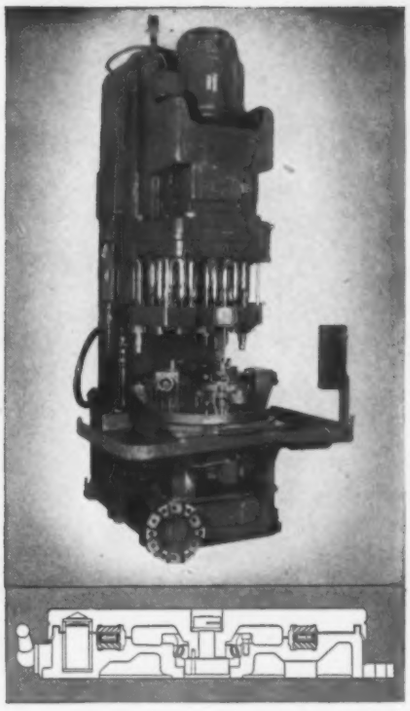
HAGAN *Automatic* COMBUSTION CONTROL

The pioneer . . . and still the leader

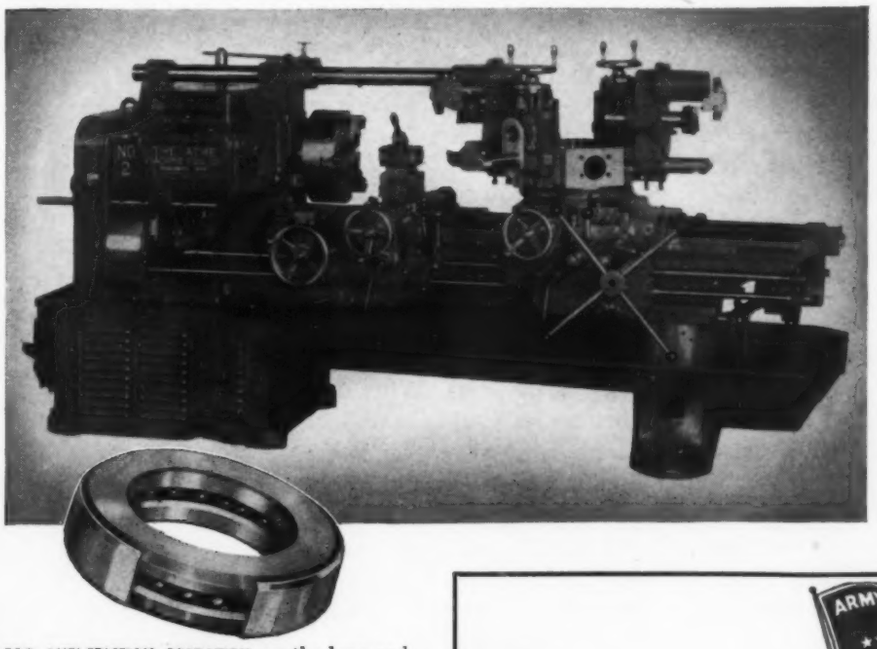
IN THE NEWS
WITH TORRINGTON BEARINGS



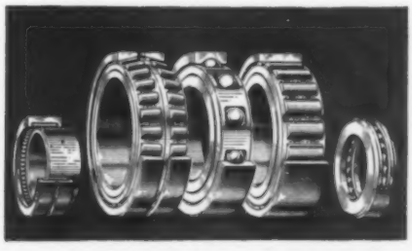
270,000 POUNDS RADIAL LOAD and 168,000 pounds thrust load is the capacity of this compact, 12.5" O.D. Torrington Mill Type Bearing designed by the Company's Bantam Bearings Division to carry the work rolls of a new design axle-type rolling mill in the steel industry. This is another interesting example of the ability of Torrington engineers to design and build anti-friction bearings to meet new and specialized requirements.



MULTIPLE STATION DRILL PRESS, built by Snyder Tool & Engineering Company, uses large Torrington Roller Thrust Bearings to provide anti-friction operation for the rotary table and insure sturdy support to the "work." Bearing, as shown in cross-section, is supplied in three sizes to meet the requirements for both hand and power indexed tables.



FOR ANTI-FRICTION OPERATION on the long and cross feed shafts of this Universal "Cincinnati Acme" Turret Lathe, built by The Acme Machine Tool Company, four Torrington banded Ball Thrust Bearings are employed in each apron. This type of Ball Thrust Bearing as shown in inset is supplied by Torrington's Bantam Bearings Division in a standard range of sizes from ½" to 3½" I.D.



THE COMPLETE TORRINGTON-BANTAM LINE includes every major type of anti-friction bearing—straight roller, tapered roller, Needle and Ball. You will find the experienced assistance of Torrington engineers helpful in selecting the *right* bearing for any anti-friction bearing problem. For today's requirements or assistance in laying out your postwar designs—TURN TO TORRINGTON!

ARMY E NAVY

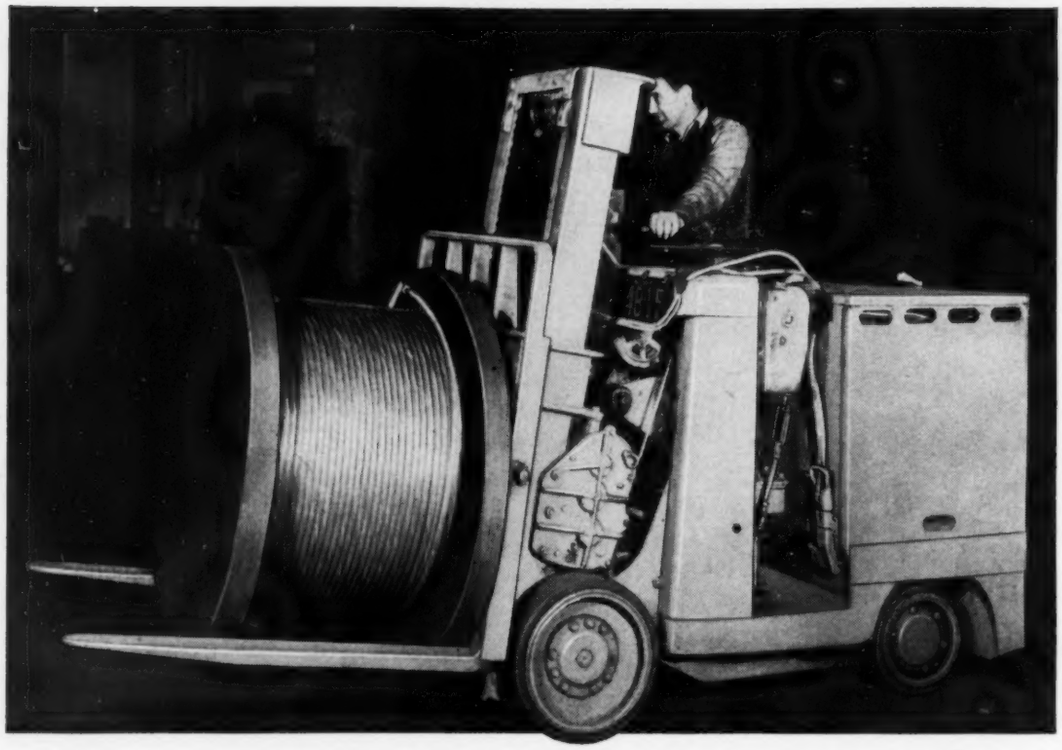
TORRINGTON BEARINGS

STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL

THE TORRINGTON COMPANY · BANTAM BEARINGS DIVISION

SOUTH BEND 21, INDIANA

STOP AND GO

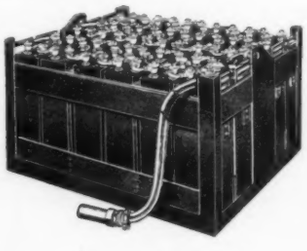


Modern, center-control fork trucks handle palletized unit loads; can also pick up and carry many types of loads without the use of any kind of dunnage. With batteries exchanged once or twice a day, they operate 24 hours a day with maximum dependability. Articles describing modern handling methods appear regularly in STORAGE BATTERY POWER. Write for sample copy if you do not already receive it.

In replacing a loaded skid box with an empty beside a machine, an industrial truck will make an average of approximately 14 moves forward, backward, up and down. A battery industrial truck has a natural advantage in this kind of stop-and-go service because it gets the necessary surges of power instantly from its battery, yet consumes no power during the stops. Thus it is not only economical of power, but the electricity used for charging its batteries is low-cost power.

Its electric-motor drive operates quietly, without vibration, and thus with well-nigh negligible repair requirements. With batteries exchanged two or three times per 24 hour day, it is continuously supplied with power and, since one battery is charged while the other works, the truck need not stop work for servicing of its power unit.

For 24 hour-a-day material-handling work, therefore, a battery industrial truck is an inherently dependable and economical machine, especially when powered by Edison Alkaline batteries. With steel cell construction, a solution that is a natural preservative of steel, and a foolproof electrochemical principle of operation, they are the longest-lived, most durable, and most trouble-free batteries. *Edison Storage Battery Division of Thomas A. Edison, Inc., West Orange, New Jersey.*



Edison
ALKALINE BATTERIES

The roll with the red wabblers
They roll more tons per grind

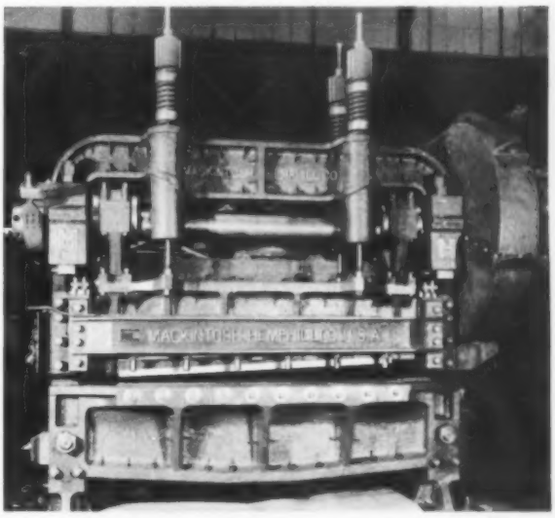
IS YOUR EYE ON QUALITY ?

ARE YOU THINKING about tomorrow's competition? Maybe you can gain the desired marketing advantage by improving the quality of your product . . . or perhaps, increased output or decreased production costs may be your answer? . . . To such problems, Mackintosh-Hemphill brings you a proved source of *advanced* industrial thinking. In the metallurgical, engineering and manufacturing end of heavy duty equipment, they offer you a complete, *balanced* service that has been an important business help to other manufacturers. For example, M-H plate rolls and shears have established new production records in dozens of plants—upped the tonnage—cut its cost—and substantially increased product quality. Write for proof of these facts.

MACKINTOSH-HEMPHILL CO.

Pittsburgh and Midland, Penna.

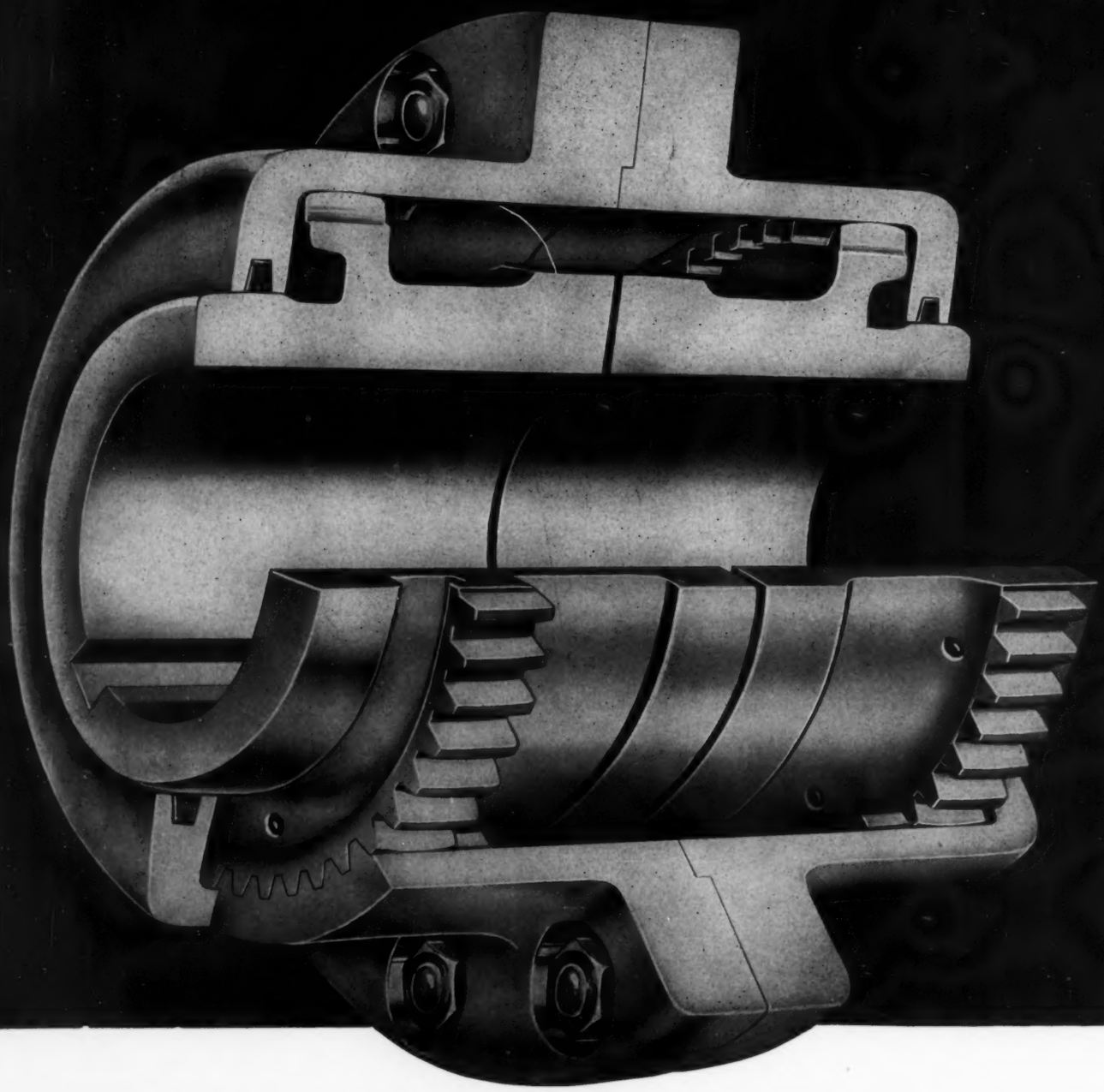
EXPERIENCE FOR SALE—Mackintosh-Hemphill's experience has been accumulating for 140 years. It is the solid foundation upon which present, progressive M-H technical minds have built their international reputation for successful industrial leadership. Today its benefits are available to you through their cooperative consulting service on the mechanical engineering end of industrial production equipment.



It takes quality to make quality. M-H plate rolls whether Nironite, Plain or Molybdenum Chill quality deliver a better finish—M-H shears assure cleaner cuts. Together they put plate production on the highest efficiency basis.

OTHER PRODUCTS: *Rolling Machinery . . . Shape Straighteners . . . Strip Coilers . . . Shears . . . Levellers . . . Pinions . . . Special Equipment . . . Iron-Steel Castings . . . The NEW Abramsen Straightener . . . Improved Johnston Patented Corrugated Cinder Pots and Supports . . . Heavy Duty Engine Lathes.*

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

Use

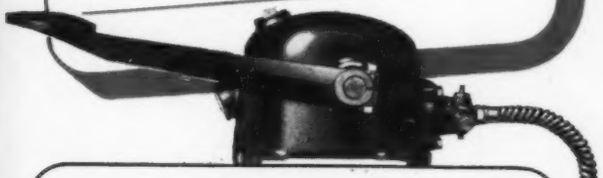
Wagner

HYDRAULIC INDUSTRIAL BRAKES

WHENEVER INDUSTRIAL MACHINERY MUST BE STOPPED QUICKLY, SAFELY, AND SMOOTHLY

CHECK THESE ADVANTAGES

1. Easy one-point adjustment.
2. Exclusive anti-drag device.
3. Hardened pins, knurled to prevent rotation.
4. Bushings at all points of maximum wear.
5. Grease fittings on all hinge pins.
6. Extra-thick friction blocks are bolted to the shoes.
7. A nationwide service organization thru 25 branches.



While the principal application for Wagner hydraulic industrial brakes is for overhead traveling cranes, there are many other applications for which they can be efficiently used.

Some of these applications are bending rolls, scrap balers, large wheel balancers, and similar applications when it is desirable to decelerate the machine by foot pressure for either normal or emergency stops.

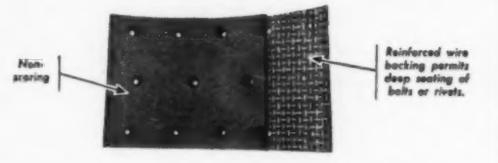
Available in Complete Systems

Brake wheel — furnished as specified to meet application.

Brake assembly — Type M illustrated.

Wagner hydraulic industrial brakes come to you complete, all ready to install. The complete system includes brake assembly, brake wheel, master cylinder, wheel cylinder, tubing, flexible hose, brake fluid, and all fittings.

REPLACEMENT BRAKE-LINING FOR ANY INDUSTRIAL BRAKE



1. Non-abrasive—will not score brake drum . . . 2. Suitable for use with any type of brake wheel . . . 3. Preformed to size and molded to wheel diameter . . . 4. Wire-backed to permit deep seating of lining bolts or rivets . . . 5. Molded blocks save installation time because they are easily applied . . . 6. Available from stock at 25 Wagner branches . . . 7. Reduces inventory by eliminating excessive stocks of roll-type lining which is generally purchased in long lengths in order to obtain the best price.

144-9

Send for Bulletins IU-20 *and* BU-145

Wagner Electric Corporation

ESTABLISHED 1891

6483 Plymouth Avenue, St. Louis 14, Mo., U. S. A.

ELECTRICAL AND AUTOMOTIVE PRODUCTS

Faster, Easier Operated

Hand lever operated type

Made also with automatic spring return

Use Quick-As-Wink Valves

This is one of the simplest types of Q.A.W. air operating valves. There are many and varied types of air and hydraulic control valves available for hand, foot, solenoid, diaphragm, lever, pilot, or cam operation. Hand operated valves are made in 3-way open exhaust and 2-way types, normally open or normally closed. No metal-to-metal contact gives extraordinary wear.

SEND FOR CATALOG AND DATA BOOK

Q.A.W. Valves may be adapted to hand, foot, solenoid, diaphragm, pilot, lever or cam control.

C. B. HUNT & SON - 1863 E. PERSHING ST., SALEM, OHIO

QUICK-AS-WINK CONTROL VALVES

THE HIGHER THE PRESSURE — AIR WATER OIL — THE TIGHTER THE SEAL

Headquarters

For Traveling Electrical Contact and Heavy Feeder System Materials

A complete line of contact rail material utilizing either rails, angles or wire as a conductor including numerous types of insulators for either under-running or over-running operation. You may also select from many types of current collectors including Junior, Universal and Pantagraph styles and contact rail shoes.

The Keystone line also includes numerous types of clamps and insulators for the insulation, suspension and dead-ending of heavy feeder cables.

These products are widely used in most large steel mills, being thoroughly proved in service. The complete catalog illustrated below will be very helpful to all interested in the construction or maintenance of cranes or feeder systems.

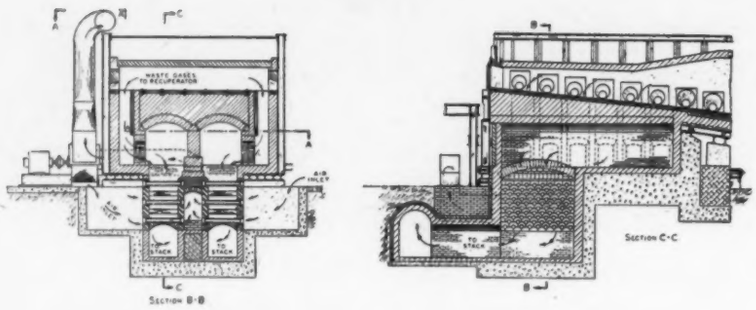
Catalog and Prices Sent Promptly on Request

ELECTRIC SERVICE MANUFACTURING CO.

Former Name—Electric Service Supplies Co.

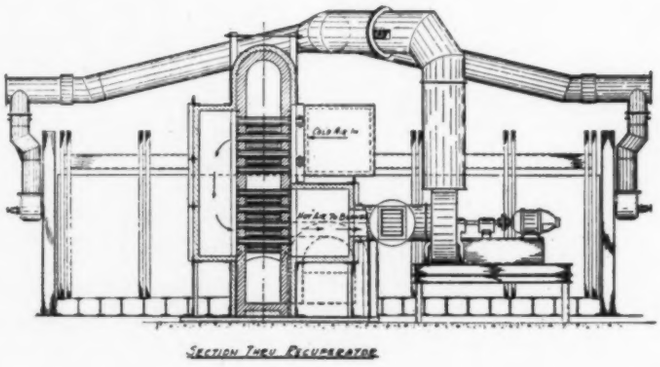
17th & CAMBRIA STREETS • PHILADELPHIA 32 • PA. • Branches in Principal Cities

"FITCH" RECUPERATORS for HEATING FURNACES

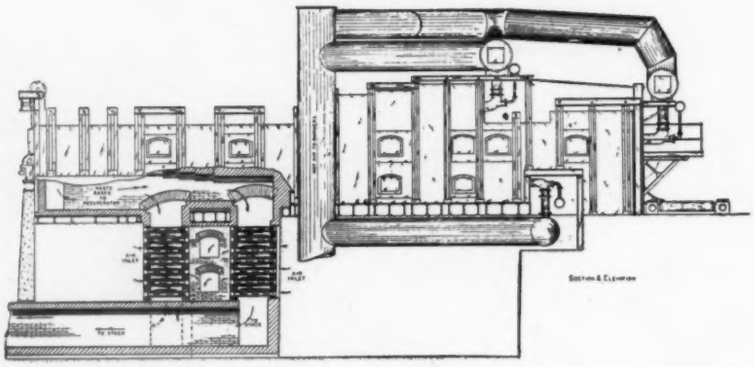


Continuous Billet Heating Furnace

Batch Type Slab Heating Furnace



Section Thru Recuperator



Continuous Slab Heating Furnace

WE DO NOT BUILD FURNACES

Write for Bulletin No. 12

"FITCH" RECUPERATORS for the STEEL INDUSTRY

FITCH RECUPERATOR COMPANY

PLAINFIELD NATIONAL BANK BLDG. PLAINFIELD, NEW JERSEY

NEWS SUPPLEMENT May 1944

Equipment
Personnel
Literature

Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

U. S. STEEL EXPANDS IN PREFABRICATED HOUSING

▲ The United States Steel Corporation recently announced completion of negotiations to acquire a substantial interest in the Gunnison Housing Corporation of New Albany, Indiana. According to B. F. Fairless, U. S. Steel president, the acquisition of this interest will provide the corporation with research facilities and the experience of an established and leading organization serving prefabricated home buyers.

"One of the best means of meeting the large postwar demand for homes for people of modest means will be through the application of mass-production methods in the prefabricated housing field," Mr. Fairless said. "To this end U. S. Steel believes that steel will make an important contribution wherever it meets the requirements of design, utility and cost."

Foster Gunnison, founder and principal stockholder of Gunnison Housing Corporation, will continue in charge of the company's affairs. A pioneer in prefabrication, he has spent many years in perfecting the Gunnison home and before the war had distributed his product from coast to coast through a wide-spread dealer organization. Gunnison homes are designed to sell generally for $2800 to $5000.

Mr. Fairless added: "Prefabricated homes should become one of the world's greatest industries and can aid substantially in postwar employment. Everything the steel industry can accomplish in the development of this new type of housing will be another milestone in the social progress of America."

NEW CARGO PLANE MADE OF STAINLESS STEEL

This new cargo plane is constructed of welded stainless steel, instead of riveted aluminum alloy sheets. With a wing spread of 100 ft, the plane will carry a cargo of 10,400 lb at 165 mph. Two 1200 hp motors are used. In full scale production by the Edward G. Budd Manufacturing Company, this plane is the first design using stainless steel on any considerable scale.

SELF-PROPELLED DIESEL-ELECTRIC ORE TRANSFER CAR FOR STEEL PLANT

▲ The first self-propelled diesel-electric ore transfer car to be used in blast furnace and steel plant service was recently completed by the Atlas Car and Manufacturing Company in their shops at Cleveland, Ohio, and was shipped operating under its own power, but in charge of a regular crew, over interstate railroad lines to its destination in an eastern steel plant. This car is in use in a plant where a complete electric conductor system is already installed. The savings resulting from elimination of conductor system maintenance, plus the cost of generating equipment in the powerhouse necessary to operate the electric cars is expected to justify the increased expense of the diesel-electric equipment, to say nothing of the safety resulting from the elimination of conductor rails from the plant yard.

The trucks are of all-steel construction of special design with the couplers mounted on the trucks.

The car is powered by two diesel engines, each rated 200 hp at 1600 rpm, and each driving a suitable generator. In fact there is a complete power equipment at each end of the car with the control synchronized electrically so that the car can be fully controlled when operating on both power plants or either one of them from the control station in either cab.

The hopper of the car is 2200 cu ft capacity, level full, and is divided into three equal compartments, each of which has an independently operated discharge gate. These gates are operated by totally enclosed, double-acting air cylinders with control valve at each operator's station. For safety reasons a special latching mechanism is provided which prevents the opening of any discharge gate until the latches have been released and prevents operation of the car until all gates have been closed and locked.

The car is equipped with straight air brakes having many special features such as automatic disconnection of power and automatic application of the brakes should the operator leave his station or should the car exceed a maximum speed of 25 miles per hour. There is additional equipment preventing operation of the car unless air pressure in the main reservoirs is sufficient to insure proper braking. Each power plant includes a complete compressor equipment, the two being properly synchronized.

ELECTRONIC RELAY WIDENS CONTROL RANGE

▲ A new electronic relay for amplifying the very limited current transmitted by delicate control contacts or high resistance circuits, thus materially increasing the application range of many control devices, has been announced by the Industrial Control Division of the General Electric Company. Operated by any material having a resistance of from 0 to 500,000 ohms, or even greater if necessary, the new relay is especially suitable for controlling liquid levels in tanks and boilers, sorting metallic parts by size, detecting broken threads in textile machines, and as a limit switch requiring extremely light pressure to operate.

Small and light in weight, thus facilitating easy installation, the new relay consists of a standard type electronic tube, a supply transformer, and an electromagnetic relay — all mounted in a totally enclosed, weather-resistant enclosure suitable for wall or machine mounting.

In operation, the electromagnetic relay in the device is kept energized as long as the controls connected to the input grid circuit of the electronic tube remain open. The instant these contacts close, the relay is de-energized. A built-in time delay feature prevents chattering when the contacts in the input circuit are momentarily closed. A contact arrangement on the electromagnetic relay permits the device to be used either to make or break a load circuit when the actuating contacts connected to the input circuit on the electronic relay are closed.

MANUFACTURER CHANGES CORPORATE NAME

▲ Selas Corporation of America (formerly The Selas Company), consulting and manufacturing gas engineers, Philadelphia, announces official change of its corporate name, as indicated. The action was necessitated by recent expansions, and by ramifications of the company's domestic and export activities. No change in organization, service, personnel or objectives is implied. In the metals industries Selas is particularly known for its development work in high-speed localized heat treatment with gas-air combustion.

SMALL STEEL TUBING STRAIGHTENED IN SIMPLE LABOR-SAVING DEVICE

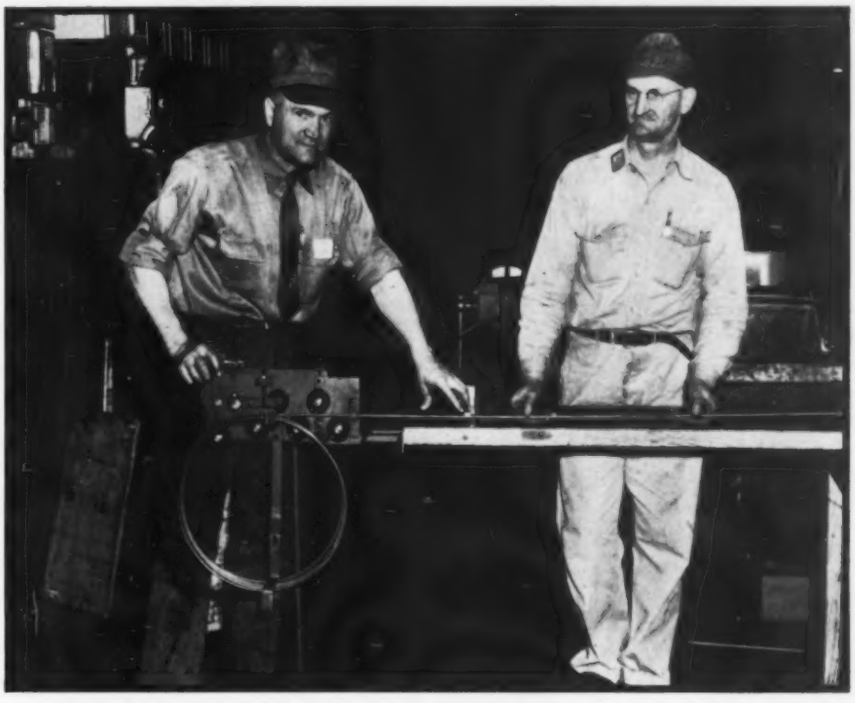
▲ A device which solves a time-consuming operation — that of straightening rolled steel tubing — has been devised by two employees at the Grove City, Pennsylvania, plant of The Cooper-Bessemer Corporation, Mount Vernon, Ohio.

Typical of many practical ideas that have been conceived and put into use to increase efficiency in engine-building at this 111-year-old company, the tube straightener is one of the simplest of any of the labor-saving tools used in the shop. Made of a few odds and ends of metal and a series of five rollers, the device eliminates former hand straightening operations which consumed many valuable man hours that could be utilized in more productive work.

The tubing, of ¼ and 5/16 inch diameter, is received in large coils and previously had to be unwound as needed, straightened with a paddle, then bent and formed to fit a specific connection.

With the new device shown in the accompanying illustration the coil is simply positioned over a bracket at the side of the contrivance, the loose end is threaded through the rollers and the tubing is straightened by pulling it out along a horizontal tray where it is measured and cut off to the required length.

With nearly a mile of such tubing used monthly in the assembling of Cooper-Bessemer diesel engines for various branches of the armed services, the tremendous saving in time and effort through the adoption of this novel machine is apparent.



Simple time-saving tubing straightener devised by Cooper-Bessemer workers Howard Knisely, (left), and Frank Babcock, (right).

TAR, LIGHT OIL YIELDS PREDICTED ACCURATELY

▲ A more accurate method of predicting the primary tar and light oil yields of various types and ranks of coal has been developed by Bureau of Mines chemists as the result of their tests on lignitic, subbituminous, and bituminous fuels, Dr. R. R. Sayers, Bureau Director, announced recently.

The chemists, W. H. Ode and W. A. Selvig, both attached to the Bureau's Central Experiment Station at Pittsburgh, Pennsylvania, said that the amount of tar and light oil can be correlated with the hydrogen content and with the volatile matter reduced by an amount equal to 1.3 times the oxygen content. Volatile matter alone is not a good index of tar and light-oil yields when coals of all ranks are considered, the chemists reported. The report describes their experiments and includes tables showing the yields from many samples of coal from various parts of the United States. Varieties or types studied include common banded, splint, cannel, cannel-boghead, and boghead-cannel coals.

A copy of the publication, Report of Investigations 3748, "Low-Temperature Distillation Yields of Primary Tar and Light Oil from Coals of Various Ranks and Types," may be obtained by writing the Bureau of Mines, Department of the Interior, Washington 25, D. C.

CRANE ATTACHMENT FOR FORK LIFT TRUCKS

▲ That machinery and equipment manufacturers are ingeniously adapting fork lift trucks to many new uses is brought to light in the plant of the Cleveland Hobbing Machine Company, Cleveland, Ohio. That company's line of Rigidhobbers and Rigidturners is being quickly and easily handled by a standard Towmotor fork lift truck equipped with a crane arm and hook attachment.

A handy attachment developed by Towmotor Corporation, Cleveland, Ohio, for use with its own models, the crane arm and hook facilities the lifting, handling and transporting of unwieldy objects. The crane arm is readily adaptable for specialized lifting operations that require reaching over obstacles such as highway truck bodies, flat cars, stock piles and shop machines as well as moving materials which have little or no under-clearance, such as engines, castings, dies, long bars, structural shapes, items of machinery and other things commonly carried by chains, slings, chain hoists and cranes.

The crane arm attachment is quickly and easily interchanged with the standard forks of the lift truck. Suspended from the lifting carriage of the lift truck in the same manner as the forks, the entire crane arm attachment rides up and down with the lifting carriage. Lifting is accomplished by the regular mechanism of the lift truck, with the standard control at the operator's position. Complete crane arm specifications, dimensions and capacities are available.

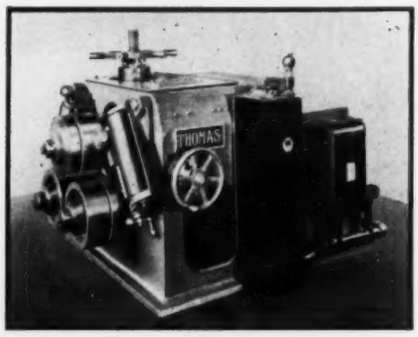
BENDING ROLLS APPLICABLE TO ALL SHAPES

▲ A completely redesigned line of bending rolls, built of electrically welded rolled steel plate, and capable of rolling angles, tees, flats, rounds, squares, pipe, beams, channels, and special shapes of almost unlimited variety has been announced by Thomas Machine Manufacturing Company, Pittsburgh, Pennsylvania.

Arcs, spirals or circles can be formed on the new machines. They are available in four sizes, comprising rolls for bending angles 2 in. x 2 in., 3 in. x 3 in., and 4 in. x 4 in. in the vertical type machine, and for bending angles up to 6 in. x 6 in. in the horizontal type. Weights for the four sizes range from 3500 to 35,000 pounds.

Replanned on the basis of exhaustive data acquired in years of building the former line of Thomas bending rolls, the new machines are all steel construction, with cast steel bearing housings welded into place. The bearings are bronze bushed and lubricated with high pressure fittings.

The vertical type benders have horizontal shafts and bend material in a vertical plane. The motor and reduction gear unit — enclosed with anti-friction bearings — is mounted on an extension of the main frame so that the machine is entirely self-contained above the floor.



No. 2 vertical bending roll in the new bending roll line announced by Thomas Machine Manufacturing Company, Pittsburgh, Pennsylvania.

The horizontal type bending rolls have the rolls on vertical shafts and roll the material on a horizontal plane. The machines are driven through a fully enclosed speed reducer, all shafts being mounted in anti-friction bearings, located in a pit below the floor. This provides free access all around the machine, as well as reducing floor space.

A feature of the machines is an adjustable auxiliary roller, which counteracts twisting and keeps the leg of the angle square when rolled leg in. When angles are rolled leg out, this roller serves as a gauge to indicate when the proper diameter is rolled. It can also be used for enlarging circles which have been rolled too small.

The work rolls are quickly adjustable in the width of slot by means of stud and lock unit. Fully hardened on wearing surfaces, the rolls are placed on the closest possible centers, thereby reducing to a minimum the length of the straight ends on finished circles. All three roll shafts, of high carbon steel forgings, are power driven, enabling small diameters to be rolled with a single pass through the machine.

The new Thomas bending roll line is completely described and illustrated in the new 8-page Thomas Bulletin No. 314.

AMPCO-TRODE 18

butt-welds crane rails successfully — in half the time required for other methods

AMPCO METAL, INC., Dept. IS-5
MILWAUKEE 4, WIS.

Reg. U.S. Pat. Off.

AMPCO Metal
The Metal without an Equal

Because, with ordinary methods, when butt welding, the high temperatures involved destroyed the heat treatment in the ball of the rail and caused "soft spots" which quickly wore down, Ampco-Trode 18 was tried and found highly successful. By the previous method, *two* welders worked for 45 minutes —with Ampco-Trode 18, *one* welder finished the job in 45 minutes. The test rails have been in operation since March, 1943 and have stood up exceptionally well. If you have a butt-welding problem, a letter or postcard will have a competent field engineer at your service immediately Or write for Ampco-Trode Catalogue 50. 8U-4

LUBRICATING KIT FOR PUNCH PRESSES

▲ The Lincoln Engineering Company, St. Louis, Missouri, has just announced that their Centro-Matic lubricating systems are now available in complete kits, ready for installation on all types of standard punch presses.

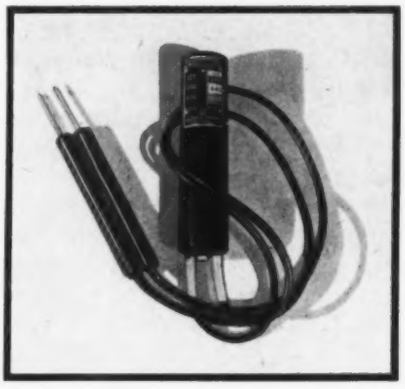
These kits contain injectors, pump, and necessary tubing brackets, bolts and fittings — everything needed for the proper lubrication of all heavy-duty bearings of punch presses.

Lincoln Centro-Matic lubricating systems have many outstanding features, such as a single lubricant supply line, injectors that can be adjusted so they will deliver a measured amount of lubricant to each bearing, and a simple hand operated pump that can be attached to the machine in an out-of-the-way position. Complete, easy to follow instructions are furnished with each kit. No special tools are required to make the installation. The manufacturer will send complete information upon request.

DEVICE GIVES COMPLETE VOLTAGE IDENTIFICATION

▲ A voltage tester that tests without lamps, gives positive voltage identification and distinguishes between a-c and d-c is offered by Square D Company.

A-c voltage markings are 110, 220, 440 and 550. D-c markings are 125, 250, and 600. Frequencies can be determined by the vibrations of the indicator. The device is housed in a cylindrical fibre case, for easy gripping, and is practically unbreakable. The 4 in. fibre grips on the leads give complete insulation and leads are 24 in. flexible wire, with double thickness, rubber insulation vulcanized to the wire to prevent slipping. A peg and spring assembly prevent sharp bending and breaking of leads where they enter the case. Sharp spear points on the ends of the leads permit piercing of wire insulation for testing without damaging it. A free folder (CA-504) is available by writing the Square D Company, 6060 Rivard Street, Detroit 11, Michigan.



This voltage tester gives positive voltage identification and distinguishes between a-c and d-c.

X-RAYS USED FOR GAUGING HOT STEEL

▲ White-hot sheet steel, at a temperature as high as 2000 F, and moving at a speed of 20 miles an hour as it emerges from a rolling mill can have its thickness accurately measured by X-rays, according to Dr. William D. Coolidge, General Electric vice-president in charge of research, in his acceptance of the Franklin Medal, awarded by the Franklin Institute.

In speaking of possibilities of X-rays Dr. Coolidge said that X-rays may be used as a thickness gage without the necessity of making mechanical contact with the work. With an X-ray outfit below and an ionization chamber or other X-ray intensity measuring device above the sheet, it becomes possible through the measurement of X-ray transmission to have a constant indication of thickness and, if desired, to have the X-rays themselves control the mill so as to maintain automatically a constant thickness of the steel sheet.

By a new method it is possible to extend the available range of X-rays up to those corresponding to a hundred million volts. Yet in the other direction, by the use of a beryllium window in the tube, X-rays at voltages as low as a thousand may be obtained. This has extended the field of application of X-rays in many directions so that they may now be used as a means of chemical analysis, to reveal hidden flaws in structural materials, to show existing strains in structural materials, and in many other ways.

BETTER PRODUCT CONTROL is possible with Hays Draft or Pressure Recorders which are a positive guide to balanced draft conditions in soaking pits, open hearths, slab mills, annealing and other furnaces. They eliminate guesswork, save man power and reduce rejects to the minimum. They are a real help in the all-out effort for bigger and better steel production.

The ten-inch, 24 hour charts give a permanent record of day in and day out performance of every furnace. Two draft values, two pressure values, two differential values or any combination of two of these three values may be recorded. Or temperature may be included if desired and mercury switches may be provided to operate an alarm or a power unit to open and close a damper, etc.

Any way you look at it, the Hays Series OT Draft Recorder is a Guard over furnace operation and merits your investigation. ***Write for Bulletin 39-232.***

The HAYS CORPORATION
SINCE 1901 COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

PURIFIER CLEANS COMPRESSED AIR

▲ The purifying division of the Bird-White Company announces a new unit, the Turbo-Rotor Pur-O-fier, which makes possible the positive purification of compressed air engineered to any volume or pressure. It eliminates the condition which exists in every compressed air system — that of moisture, scale and oil being passed along to the point of discharge.

This new unit utilizes the principle of centrifugal force, trapping moisture, oil and scale so successfully that only purified air is passed along through the compressed air system to the discharge point.

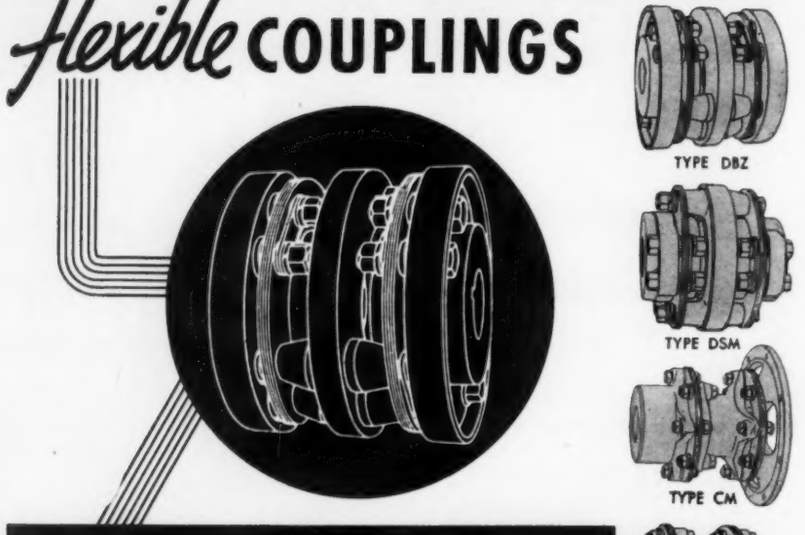
The air entering the Pur-O-fier from the intake pipe rotates a high speed, positive, non cushioning, perfectly balanced rotor, which is sensitive to velocity. The rotor beats the atomized moisture and vaporized oil into larger particles which are driven outward and downward by a shroud. As they are cooled the entrainments are drained off by gravity into a reservoir designed for manual operation. Units provided with automatic draining are also available to meet your requirements.

Openings at top of the shroud discharge purified air. The design of these baffles is based on the principle of aero-dynamics and precludes the possibility of capillary action resulting from high velocity. Patented oilless bearing guarantees long, trouble-free operation.

Models are available in two capacities, both of which may be used in multiple unit assemblies.

In addition to the velocity type Pur-O-fiers, Bird-White also manufactures power driven units that are as positive in operating performance as the smaller Pur-O-fiers. Further information may be obtained from the Bird-White Company, 3119 West Lake Street, Chicago, Illinois.

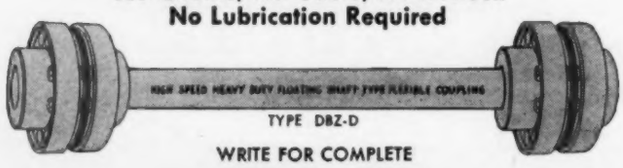
THOMAS
Flexible COUPLINGS



TYPE DBZ
TYPE DSM
TYPE CM
TYPE AM
TYPE-MT
TYPE SS

Eliminate BACKLASH, FRICTION, WEAR AND CROSS-PULL
the four destructive evils of other types and makes of couplings that prevent a permanent care-free installation.

The Thomas All-Metal Coupling has:
No Chains, No Gears, No Rubber.
No Lubrication Required



TYPE DBZ-D

WRITE FOR COMPLETE ENGINEERING CATALOG

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA

CAST HEAT-TREATED TABLE GEARS AT GARY

▲ Cast tooth table roller gears, cast and carburized in the plant foundry, have been applied to the rail mill stamping machine roller line at Gary Works of Carnegie-Illinois Steel Corporation, according to the Gary Engineers' Club bulletin. The gears are cast from a modified NE-9420 steel. After being chipped, ground and sand-blasted, the gears are packed in carburizing compound, heated to 1700 F for 65 hours in a hood annealing furnace, and cooled in the carburizing pots. Rough machining removes the carburized case from both faces and the hub, after which the gears are heated, quenched and tempered at 400 F, and the hub then finish machined. Case depth ranges $\frac{1}{8}$–$\frac{3}{16}$ in., and surface hardness of the teeth runs 80-90 Scleroscope.

The cast carburized gears give more than six months service, as compared to a three week life for SAE-1045 steel.

SPEED, EFFICIENCY WITH CABLE SPLICER

▲ The Gar-Bro cable splicing rig is a structurally self-contained unit designed to facilitate all the necessary operations in the splicing of cable.

Any standard splicing vise may be attached to the stand which is supported by a ball-bearing revolving base. Directly above the splicing vise

INGENIOUS WELDED CRANE CRADLE DEVISED FOR FLAT ROLLED PRODUCTS

▲ Plant maintenance engineers have become so adept with the electric arc that virtually every kind of metal structure used in factory operations where arc welding equipment is available, is now of arc welded design.

Welded crane cradles, are typical of the flexibility of the welding process for constructing items which serve specific requirements. This cradle was designed expressly for conveying sheet metal to stockpiles and to production lines.

The main frame of the structure consists of two pieces of 4 in. channel butted together and welded at the joints forming four square members which, in turn, are fused into one solid piece. Square pieces are cut and fitted into the ends of the longitudinal members to further strengthen the parts (see illustration)

Six U shaped pieces for holding the stock consist of ½ inch steel formed and welded on both sides at the corners as shown in Figure 1. These holding members measure about 6 by 18½ by 7½ inches and are anchored to two chain links which are fastened to larger square links on the main frame itself. The large links fit over the frame so that they can be slid to any position necessary to accommodate the various lengths of sheet metal stock.

Bar stock ½ in. in diameter is formed and welded to make up the links which hold the U pieces. Lugs, welded to the top of the main frame, to position the U members and prevent slippage, are of ¾ by ½ inch bar stock.

Four eye bolts are welded to each corner of the frame, the bolts passing through drilled holes in the frame and welded solid all around. These bolts serve as fasteners for the four chains which suspend the cradle from the crane hook.

The overall dimensions of the frame are 22 in. x 8 ft 2 in. and the cradle will handle loads up to seven tons.

PHOTO COURTESY THE LINCOLN ELECTRIC CO.

View showing welded construction of frame and "U" members of crane cradle.

is a quick opening jaw type vise supported by a tension member. The gripping vise is rapidly actuated by spinning a large heavy rimmed wheel. Any desired tension is put on the cable between the two vises by vertical adjustment of the tension member through a double-acting screw provided with a hand wheel. The cable is easily untwisted for splicing by revolving the splicing vise stand.

For compactness in shipping and handling, the top and bottom members of the cable splicing rig are detachable from the vertical member. The unit may be set up, bolted to a column or post, or lashed to a tree and be working in ten minutes. Provision is made for mounting either vertically or horizontally by means of mounting pads. The overall size, set up, is 96 in. x 45 in. The weight is approximately 250 lb, and no section weighs more than 100 lb. A perforated shelf mounted on the back of the splicing vise stand holds marlin spikes and other hand tools. Hooks are provided on the vertical member for other tools the workman uses.

Equally useful as a portable or as a permanent installation, the Gar-Bro cable splicing rig greatly increases the speed and efficiency of splicing with a great reduction in the physical effort involved. It is manufactured by Garlinghouse Brothers, 2416 East 16th Street, Los Angeles 21, California.

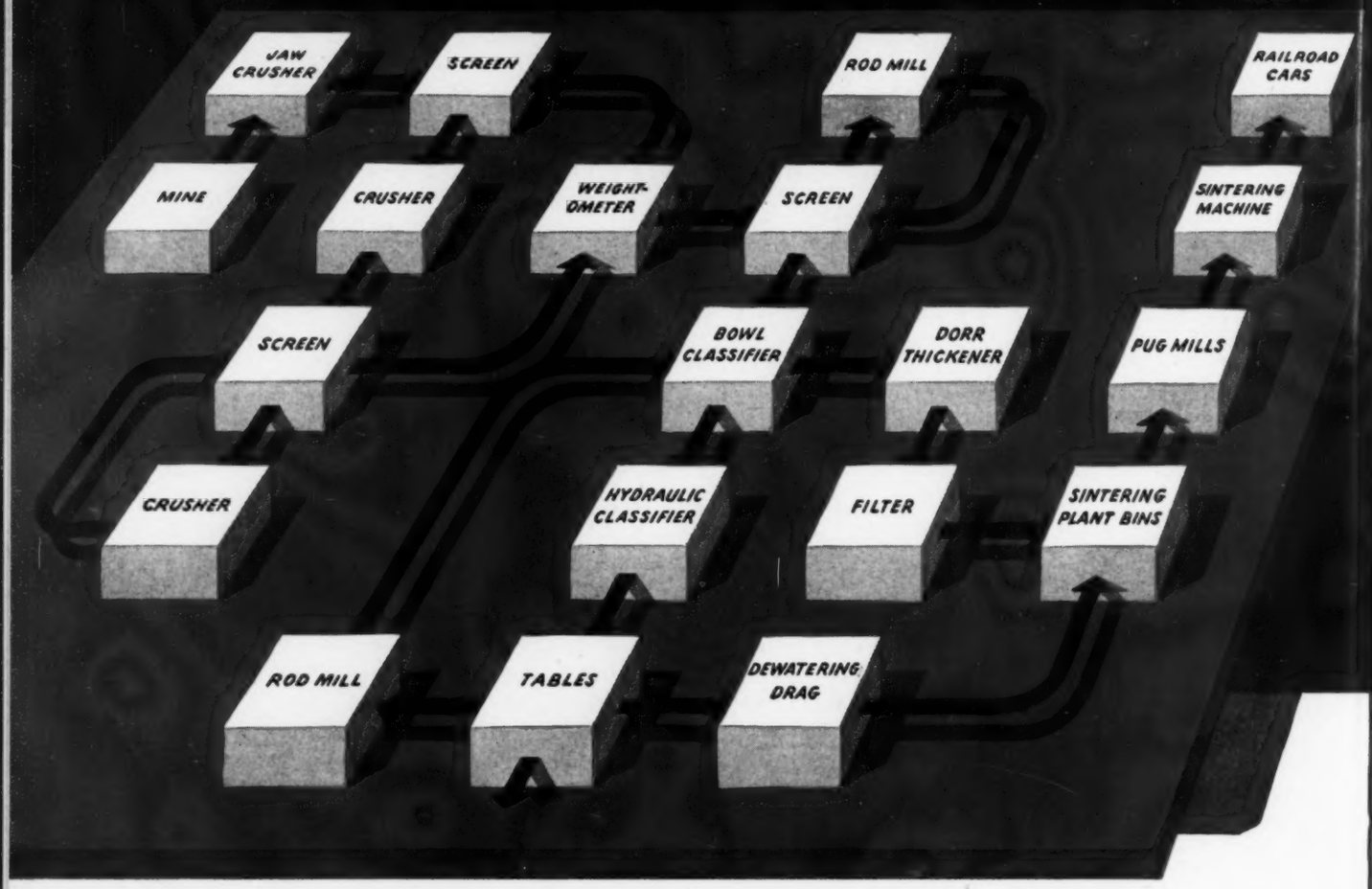
LARGER ELECTRODES FOR ARC FURNACES

▲ Research by National Carbon Company, Inc., has culminated in the development of two new and larger sizes of graphite electrodes. The new electrodes are 24 in. and 30 in. in diameter — the first graphite electrodes of these sizes produced commercially anywhere in the world. They follow by six years the company's production of the first 20 in. graphite electrodes.

The major problem to be met in increasing the size of graphite electrodes, without sacrificing other desirable physical properties, was that of strength. This problem was met and the 30 in. electrodes are proportionately as strong as the widely used 18 in. electrodes.

Although at the present time there are no electric steel furnaces which require the 24 and 30 in. electrodes, the availability of the electrodes will make possible new developments in furnace design and have an important influence on future electric furnace production.

McKee design assures an ore beneficiation plant to meet *your* sinter requirements



EVERY McKee-designed ore beneficiation plant is the result of careful study of *all* the facts which influence plant design and selection of equipment.

For each application of ore beneficiation all factors must be taken into consideration to determine correct plant design. Physical properties and seasonal movement of ores, required quantities and desired physical characteristics of sinter to be produced as well as blast-furnace or open-hearth operating conditions must be considered.

Experienced metallurgical and mechanical engineering, based on such a study, assures you a plant of efficient design with crushing, screening, concentrating, blending and sintering equipment properly correlated to provide maximum production and accurate control of physical properties of sinter with a minimum of supervision.

Arthur G. McKee & Company

★ *Engineers and Contractors* ★

2300 CHESTER AVENUE • CLEVELAND, OHIO

0 ROCKEFELLER PLAZA
NEW YORK, N. Y.

COMMERCE BUILDING
HOUSTON, TEXAS

New Literature

▲ Roots-Connersville Blower Corporation of Connersville, Indiana, has just issued Bulletin 61-B11, devoted to its cycloidal rotary pumps. This is a four page folder printed in two colors, with numerous illustrations showing various driving arrangements, including direct coupled electric motors, gasoline and steam engines, in addition to standard arrangements such as flat belt or V-belt, gear reducers, etc.

A cross-sectional view shows the three-lobed impellers which are used in both the type RF and SO pumps. Type RF pumps are suitable for handling the heavier and more viscous liquids at heads up to 150 ft while the type SO pumps handle the same kinds of liquids at heads up to 120 ft, the latter being used for larger capacities.

It is claimed by the manufacturer that these pumps are suitable for handling tar, oil, grease, asphalt, slack wax, semi-pastes, spent grain, and many others, and that, due to the rotary principle, numerous moving parts are eliminated and there are no contact points between the impellers themselves or the impellers and the case. It is also claimed that liquids and gases can be handled simultaneously.

▲ For the iron and steel industry, two new volumes of the simplified Motor and Control Buying Data are announced by the Westinghouse Electric and Manufacturing Company. The books contain pricing information, dimensions, application curves and data, and illustrated descriptive bulletins. They may be secured from the company's district offices only — no mailings from the Westinghouse headquarters in East Pittsburgh.

Both books are plastic bound, with durable 4-ply covers, and consist of selected sheets from the company's new loose-leaf system designed for quick selection and ordering. The motor book contains 724 pages, 15 index tabs; the control book, 454 pages, 13 index tabs.

Based upon careful surveys of the iron and steel industry buying practices, the new books cover equipment listed thoroughly; designs not frequently used by the industry have been omitted for the sake of space.

▲ Ingersoll-Rand announce a new 32-page catalog of compressors and vacuum pumps in sizes from ½ to 10 horsepower. This bulletin covers the well-known type "30" line of air-cooled machines with two notable additions, a 3-stage dual-pressure portable and two 3-stage high-pressure units. The dual-pressure portables are designed particularly for use at airports in the servicing and repairing of airplanes. They may be operated either at 80 to 100 lb discharge pressure, or 1600 to 2000 lb, the manipulation of a single valve changing from one pressure range to the other. The high-pressure units are 3- and 4-cylinder machines producing discharge pressures of 3000 lb and 2000 lb respectively and are designed for special industrial uses requiring such pressures for intermittent operations.

The catalog may be obtained by writing the company at 11 Broadway, New York 4, New York, for form 1052.

▲ The Oxy-Acetylene Handbook, published by The Linde Air Products Company, fulfills a need by both student and experienced welding operators, for a complete, comprehensive, and authoritative textbook on basic oxy-acetylene welding and cutting procedures. This new, durably bound, 600-page manual is invaluable as a guide for self-instruction and also as a standard classroom textbook in vocational and trade schools, technical high schools, and engineering colleges. It covers the entire range of the oxy-acetylene process, giving clear, easy-to-follow instructions for handling all the common commercial metals, together with simple explanations of the fundamental principles of the various methods of depositing and controlling molten metal. Considerable space is devoted to an explanation of the operating principles of oxy-acetylene equipment and instructions for its care and maintenance.

In addition to its use as a textbook for teaching students how to weld and cut, or teaching experienced operators how to improve their welding and cutting, the handbook will also serve as a guide and authoritative reference book for plant management people, engineers, designers, superintendents and foremen in shops where oxy-acetylene welding and cutting is used or might be used as either a production or a maintenance tool.

The Oxy-Acetylene Handbook, price $1.50, may be purchased at technical book stores, or at any sales office of The Linde Air Products Company.

▲ A 28-page booklet of convenient pocket size entitled "Care and Maintenance of Electrical Equipment" and containing simple instructions for keeping switches, panelboards and switchboards in good operating condition has recently been issued by the Square D Company. The book, which also contains a parts ordering list of Square D electrical equipment, may be obtained from Square D Company, 6060 Rivard Street, Detroit 11, Michigan.

▲ To describe its new system of combustion control designed especially for the smaller industrial or municipal power plant, Leeds and Northrup Company has just issued a new catalog, "L&N Combustion Control, Type P."

This publication shows how the system regulates fuel-feed and draft by a simple electrical balance, varying the settings of valves, dampers or vanes in definite proportion to steam demand. At the same time, furnace pressure is automatically regulated.

The application of this system to different types of boilers — stoker fired, pulverized coal fired, gas fired, and oil fired — is shown in the catalog by schematic illustrations. Several typical installations are pictured. The electrical balance action and the control of furnace pressure are shown by means of photo-diagrams.

The publication also describes how the operator — without leaving the panel — can switch from automatic control to semi-automatic or can regulate any or all of the various drive units by push buttons. This independent operation of the drive units is said to allow the controllers to be serviced without interrupting the operation of the boilers.

For more complete information about this system for the smaller power plant, write for Catalog N-01P-163, "L&N Combustion Control, Type P," Leeds and Northrup Company, 4934 Stenton Avenue, Philadelphia 44, Pennsylvania.

▲ Bulletins No. 24-A and No. 25-A of the Trico Fuse Manufacturing Company, describe an automatically controlled visible oiling method for ring or ball bearings, shafts, gear and pump housings, etc. Valuable suggestions on how to end bearing failures,

reduce motor burnouts, stop needless shutdowns for hand-oiling, eliminate fire and accident hazards, etc., are given. Write for your free copy to Trico Fuse Manufacturing Company, 2948 North 5th Street, Milwaukee 12, Wisconsin.

▲ A new catalog, No. 2010-A, on Cleveland Steelweld bending presses has just been issued by The Cleveland Crane and Engineering Company, Wickliffe, Ohio. Highly illustrated, the catalog has many photographs of varied work being performed and covers many of the details of construction. A complete table of sizes and dimensions is included.

Detailed data is also given on Cleveland Steelweld Bulldozers along with dimensions and data on the most popular sizes. Catalog No. 2010-A will be sent free upon request.

▲ A booklet on charging equipment for Exide batteries in motive power service has been issued by The Electric Storage Battery Company. It contains a complete detailed description of the two-rate and the modified constant potential systems of charging with numerous diagrams, graphs, and tables. It contains, including cover, 16 pages, 8½ x 11 in. A copy may be obtained by addressing The Electric Storage Battery Company, 19th Street and Allegheny Avenue, Philadelphia 32, Pennsylvania. and requesting a copy of bulletin 207, Charging Equipment for Exide Batteries Motive Power Service.

▲ The Cochrane Corporation bulletin 4081, descriptive of continuous blow-off systems, illustrates the application of this heat-saving device that should be a part of every boiler room auxiliary equipment.

The bulletin explains the heat saving that can be accomplished, the advantages from the standpoint of regulating boiler concentrations, the type of equipment available for different heat balance requirements, as well as illustrations and photographs of installations, heat exchangers, etc.

This bulletin, of interest to all steam users, particularly plants not already equipped with devices of this character, may be obtained from the company upon request.

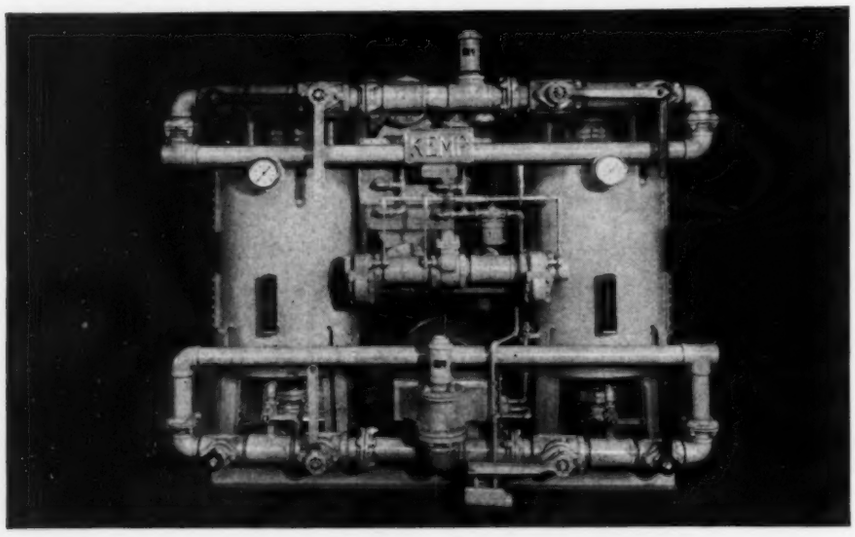
▲ Until now, the story of the cast steel breech ring has been pretty much of a "hush-hush" affair. The need for secrecy is past, and Ohio Steel Foundry Company tells the complete inside story in a new booklet "The Four Steel Castings that Made History."

Short and to the point, it contains an unusual story of the war — the development and production of these breech rings. The booklet is obtainable upon request to the company at Lima, Ohio.

▲ The Meehanite Research Institute of America, Pershing Square Building, New Rochelle, New York, has published bulletin No. 18 entitled "Meehanite — the Metal for Post-War Castings." This four-page illustrated folder describes a variety of recent applications of Meehanite castings for highly stressed parts, formerly specified as steel or high alloy castings. A copy will be sent free upon request.

▲ Chain Belt Company of Milwaukee has just issued a new catalog descriptive of REX Z-Metal chain belts for better and more economical drive and conveyor service in many industries.

REX Z-Metal is a ductile ferrous



Whatever your drying problem . .

KEMP HAS SOLVED IT BEFORE

K. S. G. silica gel adsorptive dryers are speeding forced draft production in every war industry* that faces problems in drying gases, liquids or solids.

Kemp Silica Gel Dryers are available on prompt notice in a wide variety of standard types and sizes, while specially engineered units to meet special requirements are furnished as quickly as war conditions permit. To summarize, standard units are made in capacities from ten to 100,000 c. f. m., from atmospheric pressure to very high pressures. Activation is by gas, electricity or steam as desired, with single tower units for intermittent operation or twinned towers for continuous production.

To paraphrase a famous (and living) U. S. General, standard units may be had RIGHT NOW, special designs will take a little longer.

C. M. Kemp Mfg. Co., 405 East Oliver Street, Baltimore-2, Maryland.

***Except the dehydration of foods, which is a different problem altogether.**

KEMP of BALTIMORE

cast metal with a high tensile strength (more than 30 per cent stronger than good malleable iron), and a correspondingly high yield point. It is an exceptional material for use in cast chain belts because of its strength and toughness, giving it the ability to absorb shock loads and to effectively resist wear under some of the toughest operating conditions. Although Z-Metal is not stainless, it resists the corrosive action of many acids and alkalis which actively attack malleable iron or steel.

Z-Metal chain belts are made in many styles, types and sizes for every kind of drive and conveyor service. In addition to Z-Metal chain belts, the Chain Belt Company also manufactures malleable iron chain belts, steel chain belts and high speed roller chain belts.

A copy of the REX Z-Metal chain belt bulletin may be obtained upon request.

▲ Sixteen interesting industrial uses of high frequency electrical induction are featured in a new, well-illustrated 32-page booklet entitled "Results With Tocco" which has just been published by The Ohio Crankshaft Company, Cleveland, Ohio. The progress made by high frequency induction during 1943 is clearly set forth.

Among the more recent case stories described is the hardening of a 26 in. final drive gear that has resulted in an annual savings of 144,000 pounds of nickel formerly required. The gear is today made of plain carbon steel. Another application, the hardening of a drill chuck body eliminated rejects, boosted output by 600 per cent and saved more than $7300 annually.

Further, histories of the heating of shell forgings to 2100 F in 13 seconds (so fast the body remains cool and can be handled without tongs) show how scale is reduced and die life is lengthened. The brazing of adapters (silver soldering) to mortar shells in 20 seconds is depicted revealing that complete uniformity of braze is achieved without affecting the physical properties of the shell.

▲ Anyone in steam plant or process industry who is concerned with preventing contaminated condensate from reaching boilers and prime movers, and who does not have Leeds and Northrup Company's catalog, "Micromax Condensate-Purity Instruments for the Steam Plant," should be interested in the 23-page, revised edition of this publication just issued.

Embodying only minor changes in text, the catalog describes how condensate is sampled continuously by means of a conductivity cell, and its purity indicated and recorded automatically by means of a Micromax recording instrument. When contamination is present, the recorder can flash a signal or sound an alarm so that the operator can correct the condition. Instead of operating a signal, or in addition to operating one, the Micromax instrument can (if so equipped) control a valve and automatically divert contaminated condensate to waste. A simple L&N signalling conductivity controller, which neither indicates nor records — just signals and controls — also is listed in this publication for the first time.

Write for Catalog N-95-163, "Micromax Condensate–Purity Instruments for the Steam Plant," Leeds and Northrup Company, 4934 Stenton Avenue, Philadelphia 44, Pennsylvania.

CROUSE-HINDS

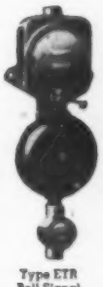
Explosion-Proof and Dust-Tight

Industrial Signal Condulets

(CONDULETS are manufactured only by CROUSE-HINDS)

Type ETH Siren Signal

Type ETH Howler Signal



Type ETR Bell Signal

A Nationwide Distribution Through Electrical Wholesalers

For hazardous locations where there is danger of explosions from the use of ordinary electrical equipment. This includes any place where gas, gasoline, petroleum, alcohol, paint, lacquer or any other highly flammable substances are manufactured, used or stored; or wherever the atmosphere contains combustible dust such as carbon black, coal or coke dust.

For use in noisy places or where signals must be heard from a distance.

Plain or coded signals, alone or in connection with a telephone.

Alarms: for fire; changes in liquid levels, gas or air pressures.

Factory sealed: with pigtails in an explosion-proof junction Condulet for splicing to line wires.

Type ETH Siren and Howler Signals. 6 to 250-volt A. C. or D. C.

Type ETR Bell Signals. Continuous vibration; 110-volt Universal motor. Single stroke; 110-volt, 60-cycle A. C. Solenoid operation.

Listed in Condulet Catalog No. 2500, Section 85, Page 12C

CROUSE-HINDS COMPANY
SYRACUSE 1, N. Y., U.S.A.

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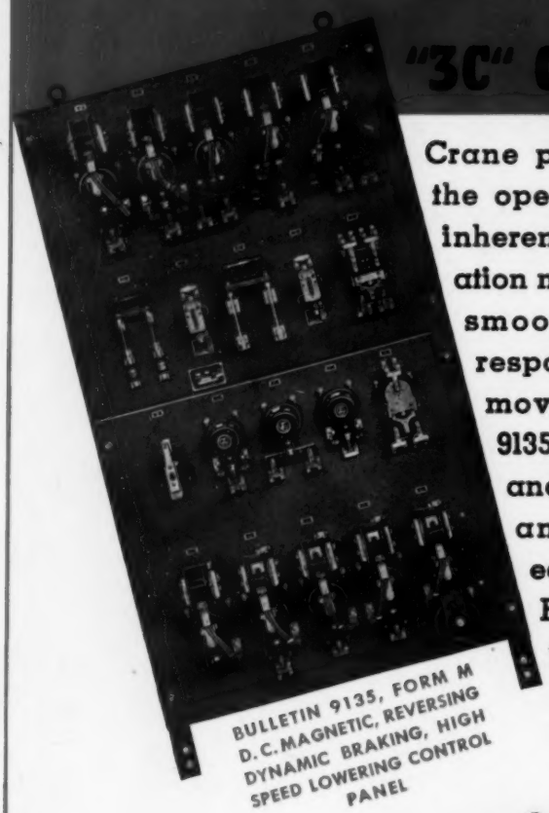
CONDULETS • TRAFFIC SIGNALS • AIRPORT LIGHTING • FLOODLIGHTS

FOR BETTER PERFORMANCE ON CRANES
USE
"3C" CRANE CONTROL

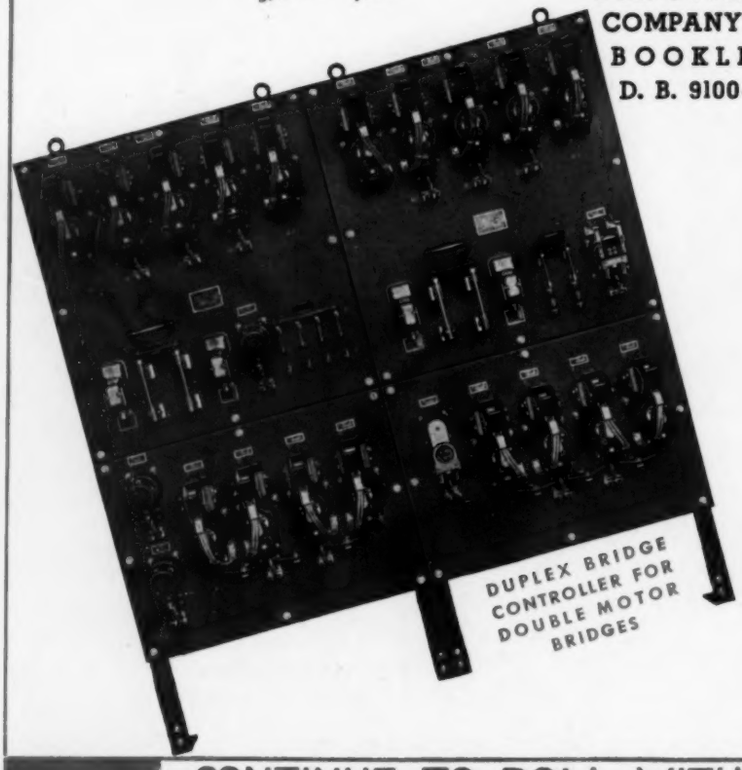


BULLETIN 9135, FORM M
D. C. MAGNETIC, REVERSING
DYNAMIC BRAKING, HIGH
SPEED LOWERING CONTROL
PANEL

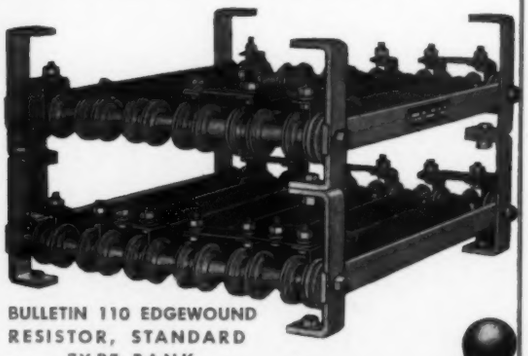
Crane performance is judged by the operator. Safety must be an inherent characteristic. Good operation means good speed control, smooth acceleration, quick response to master switch movement. "3C" Bulletin 9135 Form M Hoist Control, and Bulletin 9136 Bridge and Trolley Control equipments produce BETTER Crane performance–performance that suits the operator.

BULLETIN 9136
CRANE CONTROL
BRIDGE AND TROLLEY
PANEL

FOR COMPLETE INFORMATION, WRITE ON COMPANY LETTERHEAD, FOR DESCRIPTIVE BOOKLET D. B. 9100-1.



DUPLEX BRIDGE
CONTROLLER FOR
DOUBLE MOTOR
BRIDGES



BULLETIN 110 EDGEWOUND
RESISTOR, STANDARD
TYPE BANK
CONSTRUCTION

BULLETIN 101
TYPE RD, CRANE
MASTER SWITCH

CONTINUE TO ROLL WITH CLARK CONTROL

THE CLARK CONTROLLER CO.

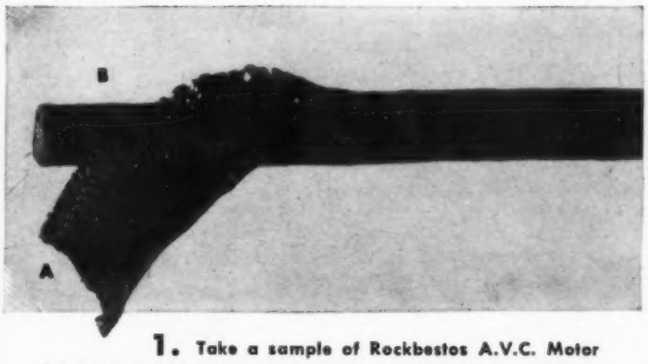
1146 EAST 152ND ST. CLEVELAND, OHIO

Don't take our word for it —

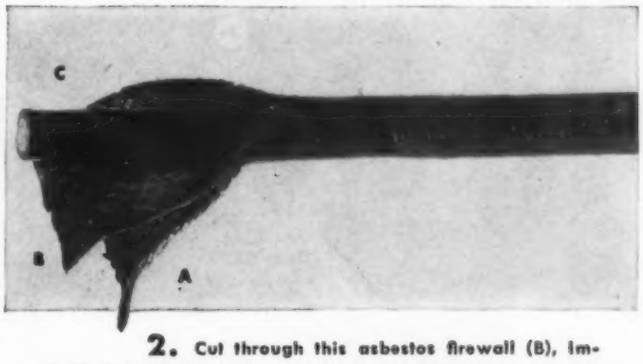
MAKE THIS SIMPLE TEST AND SEE FOR YOURSELF

Why PERMANENTLY INSULATED ROCKBESTOS A.V.C.

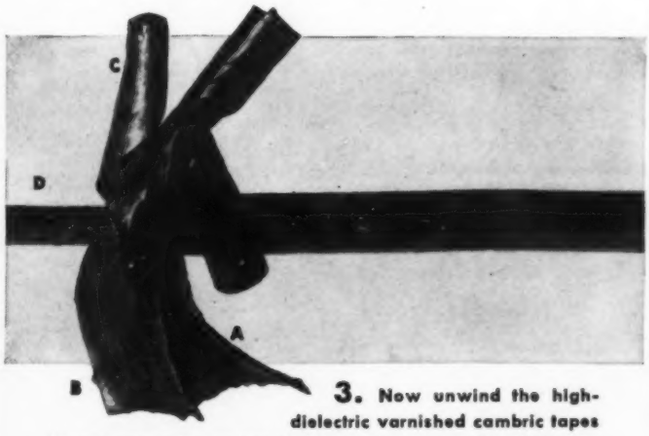
Gives Long-Lived Service Under Severe Operating Conditions



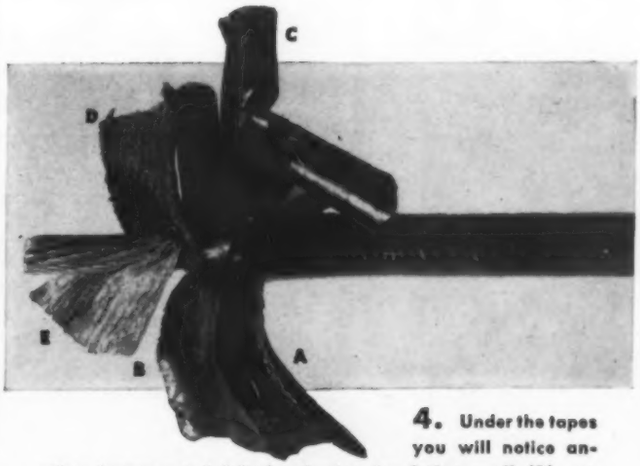
1. Take a sample of Rockbestos A.V.C. Motor Lead Cable (illustrated), or similarly insulated Power Cable, slit open the slick-finished, heavy asbestos braid (A) impregnated with heat, flame and moisture resisting compounds — a braid that won't dry out, crack or flow under heat; won't bloom, swell or rot as a result of contact with oil or grease; and won't burn or carry flame — and beneath it you will find a firewall of felted asbestos (B).



2. Cut through this asbestos firewall (B), impregnated like the braid, but felted into a permanent insulation that is resistant against heat, flame and moisture — an insulation that won't burn, bake brittle or crack with vibration — and next you'll see the lubricated varnished cambric tapes (C) which it protects from high ambient temperatures and oxidation.



3. Now unwind the high-dielectric varnished cambric tapes (C) and you will see the obvious advantages of helical construction — for uniform coverage, for dielectric stability, and to assure, together with the helically applied felted asbestos, perfect and permanent centering of the conductor in the insulation.



4. Under the tapes you will notice another impregnated felted asbestos insulating wall (D), an inner heat-barrier put there to complete the protection of the varnished cambric from the heat of conductor overloads. Slit and peel back this felted wall and beneath you'll find a thin wrapping of paper (E) over the conductor to keep it clean and make stripping easier.

Try the simple test outlined above on a sample of Rockbestos A.V.C. cable, which we will send on request, and you'll readily see why permanently insulated Rockbestos A.V.C. wires, cables and cords resist heat, flame, moisture, corrosive fumes, oil and grease — and give long-lived service under high temperatures and severe operating conditions. Write:

ROCKBESTOS PRODUCTS CORPORATION
941 Nicoll St., New Haven 4, Conn.

ROCKBESTOS A.V.C.

The Wire With Permanent Insulation

122 different wires and cables have been developed for severe operating conditions by Rockbestos

FOR VICTORY — BUY WAR BONDS!

NEW YORK, BUFFALO, CLEVELAND, CHICAGO, PITTSBURGH, ST. LOUIS, LOS ANGELES, SAN FRANCISCO, SEATTLE, PORTLAND, ORE.

"Neither snow, nor rain, nor heat, nor gloom of night, stays these couriers from the swift completion of their appointed rounds."

This quotation from Herodotus, which appears on the facade of the New York City Post Office, sums up one of the many advantages which you will receive when you install Morgan-Isley Regenerative Combustion Control. Even the "gloom of night" is not seriously disturbed, for the spent gases have stored the greater portion of their heat in the enlarged checkers, and the blast of cool air has mixed integrally with the gases in the venturi ejector tube.

Highest Efficiency — not affected by gas temperatures because operation of the system is controlled by the blowers, as shown.

No Leaks — Low Maintenance — Improved gate valves, remote controlled, are not exposed to hot gases — not subjected to violent temperature changes.

Increased Regenerator Capacity—Strong push and pull action permits use of extra regenerator chambers which promote higher temperature of combustion air.

No Variation in Air Supply During a Reversing Period — again a strong and constant push and pull action without time lag.

Increased Furnace Capacity due to better and more efficient combustion, quick positive reversal.

Power Saved—because *two* fans are used, each of proper capacity for its function.

Installation Economy — requiring less steel, smaller foundation, than demanded by the usual tall stack with its elaborate valve system.

V-45

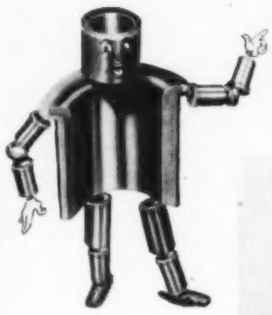
MORGAN - ISLEY COMBUSTION CONTROL

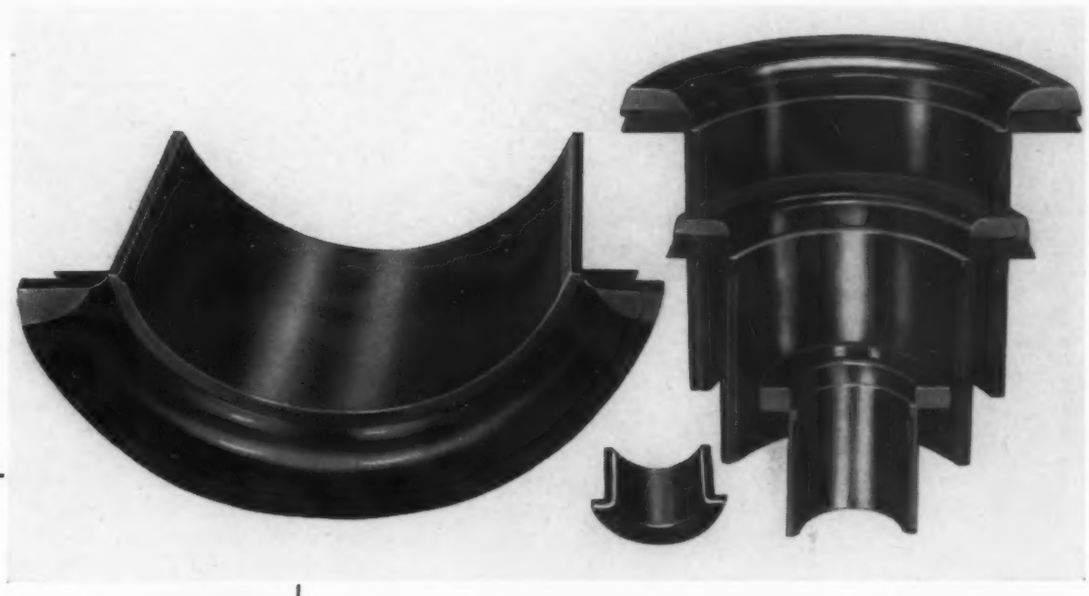
MORGAN CONSTRUCTION COMPANY

WORCESTER, MASSACHUSETTS

GATKE BEARINGS *Save Millions*

FOR THE ROLLING MILL INDUSTRY





GATKE Slipper Bearings revolutionize Universal Coupling performance. They stop deafening noise and vibration. Outwear bronze ten to one. Eliminate scoring and wear to sockets. Made to required size — no machining necessary. Send specifications for quotation.

Annual earnings and savings exceeding $60,000 directly traceable to GATKE Bearings on a small Merchant Mill are reported by the superintendent.

These substantial benefits resulted from more accurate maintenance of gauge, elimination of hot necks and neck breakage, reduced maintenance costs, power savings, etc.

Immeasurable benefits such as continuous operation, increased production, fewer screw-down adjustments, and reduced load on driving equipment were considered of equal importance to the substantial traceable economies.

These results are typical of GATKE Bearing performance on hundreds of mills.

Write for literature or send data on your mill for recommendation.

GATKE CORPORATION
228 N. La Salle St. Chicago 1, Ill.

Other **GATKE PRODUCTS**
Brake Lining
Clutch Facings
Friction Blocks
Silent Gears
Pump Valves
Piston Rings
Sheet Packings

Gatke NON-METALLIC MOULDED FABRIC Bearings

For Roll Necks, Universal Couplings, Spindle Carriers, Table Rolls, Cranes, Acid Resisting Service, and Other Tough Jobs.

Personnel News

James D. Kelly, business manager of the Iron and Steel Engineer and other publications of the Association of Iron and Steel Engineers, has left the organization to join the United States Navy, suspending a connection which began in 1927 when he became associated with his father, the late John F. Kelly, first managing director of the Association.

JAMES D. KELLY

A native of Pittsburgh, Mr. Kelly attended Duquesne, Columbia and Pittsburgh universities. His constant efforts were ever directed to the advancement and improvement of the Iron and Steel Engineer, with results that have been readily apparent. He is now located at the United States Naval Training Center at Bainbridge, Maryland.

Howard L. Dawson, for the past year assistant chief engineer for the Carnegie-Illinois Steel Corporation, has been named chief industrial engineer. Mr. Dawson succeeds **L. J. King** who has been transferred to the U. S. Steel Corporation of Delaware.

After studying machine construction and metallurgy at Carnegie Institute of Technology, Mr. Dawson began his continuous service with the company in 1912 at the Edgar Thomson Works. He served at the plant as draftsman, efficiency engineer, construction engineer, and master mechanic, becoming superintendent of maintenance in 1933.

He was transferred to the Pittsburgh general offices as engineer in charge of repairs, maintenance and lubrication in 1939, and in 1940 became chief engineer, Pittsburgh district. He was named assistant chief engineer for the company last July.

Dr. Robert H. Aborn has been appointed supervisor of physical metallurgy at the research laboratory of the United States Steel Corporation of Delaware in Kearny, New Jersey.

Dr. Aborn, a member of the staff of the laboratory since 1930, has specialized in research on alloy steel as well as in welding and in 1941 was awarded the Lincoln Gold Medal of the American Welding Society.

He began his career in the steel industry with the Bethlehem Steel Company's blast furnace department in 1920 and later was with the Watertown Arsenal and in the research laboratory of applied chemistry at the Massachusetts Institute of Technology. He also spent two years in teaching and research under Professor Albert Sauveur of Harvard University, which was prior to joining the staff of the United States Steel research laboratory.

Paul F. Mumma has been appointed general superintendent of Ellwood Works of National Tube Company, it was announced recently.

He succeeds **L. J. Mason,** newly-elected vice-president of another United States Steel subsidiary, Tubular Alloy Steel Corporation at Gary, Indiana.

Mr. Mumma has been an assistant general superintendent at Ellwood since last October. Previously he was superintendent of the open hearth and Bessemer departments at the company's National Works, McKeesport, Pennsylvania.

He attended Gettysburg College and was graduated from Lehigh University as a metallurgical engineer.

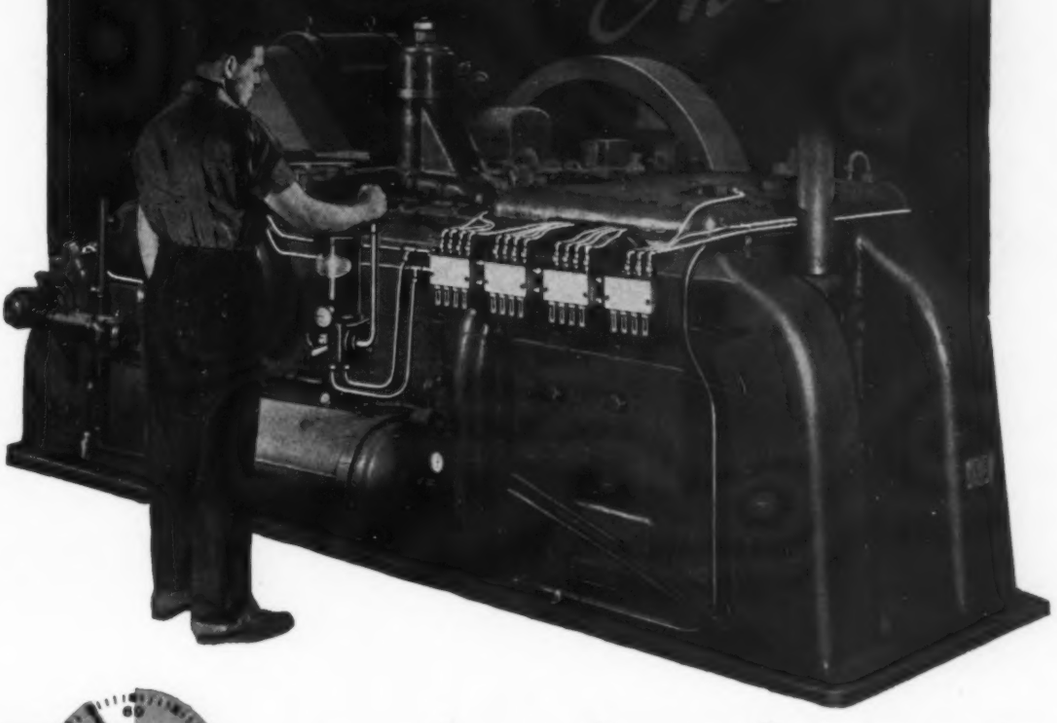
Edmund S. Davenport has been appointed assistant to **R. E. Zimmerman,** vice-president, research and technology, United States Steel Corporation of Delaware, it was announced recently.

Joining the staff of the research laboratory of the United States Steel Corporation, Kearny, New Jersey, in 1929, Mr. Davenport since 1935 has supervised the work of the metallurgical section of that laboratory.

Mr. Davenport's chief activities with the United States Steel Corporation have been studies of heat treatment problems, particularly in connection with the isothermal transformation of steel, for which he was awarded the Robert W. Hunt Medal of the American Institute of Mining and Metallurgical Engineers in 1931. In 1939, in connection with his research on this subject, he was honored by the American Society for Metals in being asked to deliver the Campbell Memorial Lecture for that year.

He was graduated from Yale University in 1919 with the degree of Ph.B., and in 1921 received a master of science degree in metallurgy from the same school. For two years he conducted metallurgical research for Eastern Malleable Iron Company, and for seven years

HOW TO LUBRICATE ALL OF YOUR BEARINGS *At Once*



in less than 1 minute!

INSTEAD of taking one minute for **each** bearing, your oiler can lubricate **all** bearings in a *half* a minute—from one safe, central point.

With Farval the operator gives the Central Pump a few strokes and—without leaving his safe position at floor level—delivers a measured quantity of oil or grease to all the bearings on the machine, *missing none.*

By maintaining a continuous film without waste of lubricant, the Farval Centralized System eliminates shutdowns to lubricate or to replace bearings—reduces power consumption by as much as 20%—and prolongs bearing life from 5 to 25 times.

Positive lubrication by Farval is helping to reduce costs throughout the Steel Industry. Farval men will plan the correct Systems for *your* Cranes, Shears, Mills, Tables, Ore Bridges, Furnaces, Levellers and other equipment. Write today—or *wire.*

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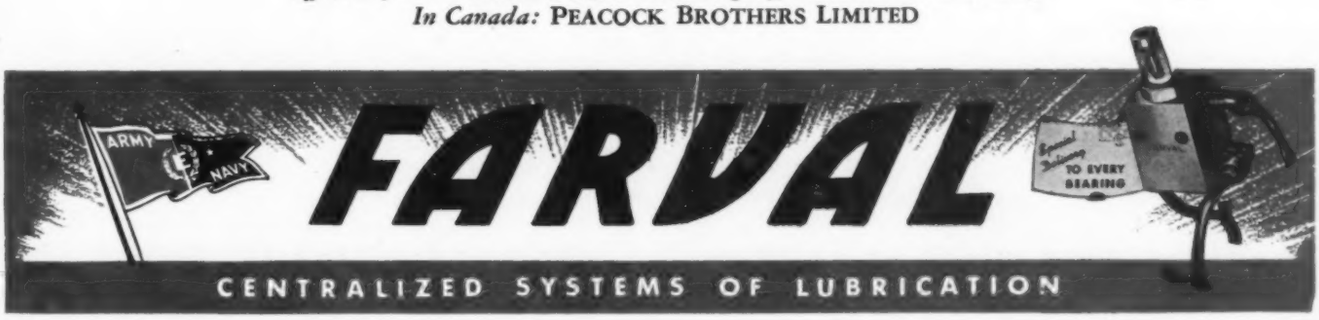
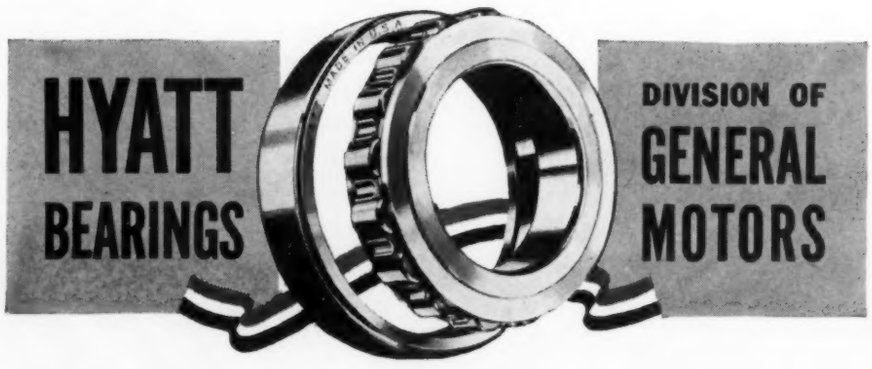


To Help Win the War...

the order of the day here at Hyatt is precision ...high precision...*super*-precision! The purpose of this precision is to give machinery greater capacity and greater performance and *greater* service life! With husky Hyatt Roller Bearings carrying the loads you can keep your machines...and your war production... steadily on the go!

HYATT ROLLER BEARINGS
SERVE SILENTLY,
ACCURATELY, EFFORTLESSLY
WHEREVER GEARS, SHAFTS,
AND WHEELS TURN



HYATT BEARINGS DIVISION · GENERAL MOTORS CORPORATION · HARRISON, NEW JERSEY

prior to joining the United States Steel Corporation, he was metallurgist at the Westinghouse Lamp Company.

D. B. Gooch has been appointed sales manager for the C. M. Kemp Manufacturing Company, 405 East Oliver Street, Baltimore, Maryland.

Mr. Gooch was sales engineer with the Blaw-Knox Division of Blaw-Knox Company, New York, during the past eight years. Prior to that, he was sales engineer with J. P. Devine Manufacturing Company, Incorporated, Mount Vernon, Illinois, for seven years.

Previous to these connections, he was chemist for the Gulf States Steel Company, Gadsden, Alabama, and assistant chemical engineer for the Gulf Refining Company of Port Arthur, Texas.

Mr. Gooch is a B.S. in chemical engineering from Albama Polytechnic Institute, class of 1927.

James A. Rowan has been appointed director of public relations and advertising for Great Lakes Steel Corporation, Ecorse, Michigan. Formerly of New Rochelle, New York, Mr. Rowan came to Great Lakes from the War Production Board, where he served as special assistant to the director of the steel division. He had previously served as news and markets editor of Iron Age, industrial editor of the Pittsburgh Press, managing editor of the Youngstown Telegram and the Brazilian-American Magazine, and correspondent in South America for the Chicago Tribune.

Dr. Robert B. Sosman and **Dr. James B. Austin** have been appointed assistant directors of U. S. Steel's research laboratory at Kearny, New Jersey, it was announced recently.

Dr. Sosman is a 1903 graduate of Ohio State University where he received his bachelor of science degree in chemistry. Among other degrees, he has been awarded a Ph.D. by Massachusetts Institute of Technology and doctor of science by Ohio State. After twenty years as physicist in the geophysical laboratory of the Carnegie Institution of Washington, he joined the staff of the United States Steel research laboratory in 1928. He is the author of several volumes on high temperature gas thermometry, and on the properties of silica and has contributed numerous papers in American and foreign technical periodicals in connection with this field of research.

Dr. Austin was graduated from Lehigh University in 1925 and received a Ph.D. degree from Yale University in 1928. He has been a member of the staff of the research laboratory of United States Steel since 1928, the year in which it was established. Since 1941, he has been in charge of the physical-chemical research section, and his activities have been chiefly in the field of investigations of high-temperature chemistry, particularly the chemistry of blast furnaces and steelmaking processes. He is the author of a book entitled, "The Flow of Heat in Metals."

J. C. Glover, formerly superintendent of the rolling mill, has been made assistant general superintendent, Copperweld Steel Company, Glassport, Pennsylvania.

PURDY PIX

J. RALPH PATTERSON

J. Ralph Patterson, vice-president in charge of sales, and **C. Howard Paul,** treasurer and assistant to the president, have been elected to the board of directors of Mackintosh-Hemphill Company.

Mr. Patterson has been associated with the company since Pittsburgh Iron and Steel Foundry, where he was a member of the engineering staff and sales representative, was absorbed by Mackintosh-Hemphill in 1922. He served successively as assistant manager and manager of Adamite sales, manager of roll and alloy sales, and general sales manager before being named vice-president.

Mr. Paul first joined Mackintosh-Hemphill as a stenographer in 1917. He became successively chief cost accountant and chief clerk. In 1924 he was appointed assistant treasurer, and in 1933 treasurer. He became assistant to president J. S. Ervin in 1939.

L. J. King has been appointed cost planning supervisor of United States Steel Corporation of Delaware, it was announced recently. Before coming to the Delaware Corporation, Mr. King was chief industrial engineer for Carnegie-Illinois Steel Corporation.

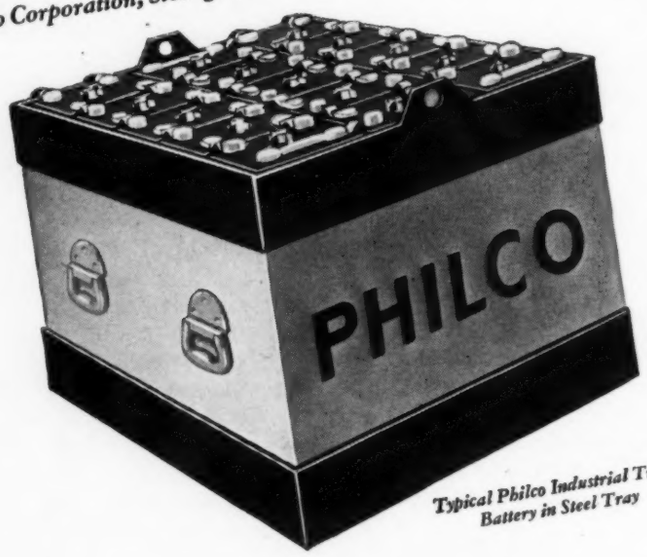
A 1924 graduate of the University of Pittsburgh with a degree of B.S. in engineering, Mr. King was first employed by Carnegie-Illinois in 1929 as an industrial engineer at Homestead Works. In 1933, he went to the U. S. Steel general office as an industrial engineer and was made chief industrial engineer in 1936.

PHILCO "XL" BATTERIES

put 10% more power capacity in your present Electric Industrial Trucks!

YES, with Philco "XL" Batteries, your present electric industrial trucks will haul 10% more material! You'll get this extra work out of your materials handling equipment because Philco "XL" Batteries provide 10% extra capacity at no increase in overall battery size! Now, when you need maximum service from your trucks, find out about Philco Batteries. Drop us a note stating truck make and model. We'll tell you exactly how much more ampere-hour capacity you can get with a rugged, dependable Philco!

Philco Corporation, Storage Battery Division, Trenton 7, New Jersey



Typical Philco Industrial Truck Battery in Steel Tray

Specify

PHILCO
INDUSTRIAL TRUCK
BATTERIES

After a transfer to H. C. Frick Coke Company in 1938, he was made chief industrial engineer of Carnegie-Illinois in 1940.

Harold B. Ressler, vice-president of Joseph T. Ryerson and Son, Inc., who has been located at the New York plant, will move to the executive offices in Chicago, where he will be in general charge of sales in all territories.

HAROLD B. RESSLER

Mr. Ressler has been with the company for many years and is very well known in the steel industry.

Ainslie Y. Sawyer, assistant to president, is elected vice-president. He will continue at Chicago in general charge of purchases. Mr. Sawyer has just recently returned from Washington, where he has been serving the war effort as deputy chief of the warehouse steel branch of the War Production Board.

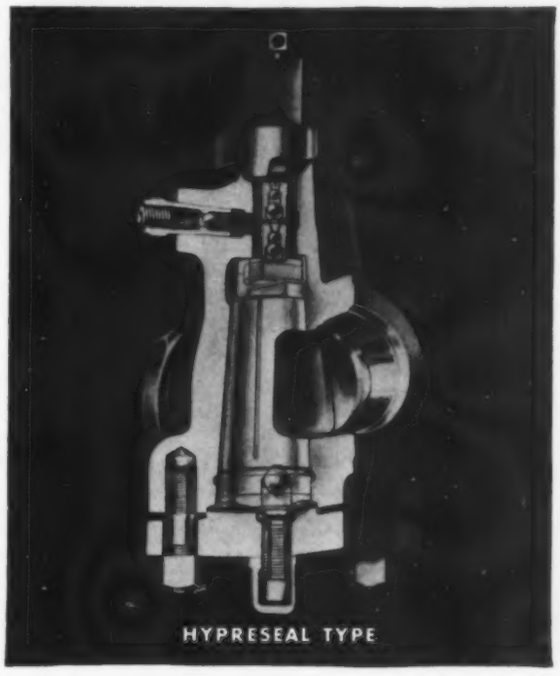
Harry W. Treleaven, assistant manager of the Ryerson New York plant, is appointed manager of that plant, which is located in Jersey City.

Thomas Z. Hayward, who is appointed assistant general manager of sales, was in charge of tubing sales and priorities. Mr. Hayward has been with the Ryerson Company for twenty-seven years, and has also served as assistant manager of sales of the Chicago plant.

E. N. Sanders has resumed his position as vice-president in charge of operations, National Tube Company, after 20 months as vice-president in organizing the new Tubular Alloy Steel Corporation plant at Gary, Indiana, it was announced by C. R. Cox, president of both these U. S. Steel subsidiaries. At the same time, Mr. Cox announced the election of **Leo J. Mason** as vice-president at Tubular Alloy, succeeding Mr. Sanders. Mr. Mason, since 1940, has been general superintendent of National Tube's Ellwood City Works. Both men will also serve as directors of their companies.

Walter D. Smith of Tulsa, Oklahoma, has been appointed commercial vice president of the Worthington Pump and Machinery Corporation. A graduate of Car-

NORDSTROM
Lubricated Valves



Leak-resistant
Quarter turn to open
Floating plug
No exposed seat
Plug seated on lubricant film
"Sealdport lubrication
Corrosion-resistant
Erasion-resistant

Widely used in steel plants — on gas, chemical and oil lines — for positive control, regardless of pressure or temperature.

Keep Upkeep Down

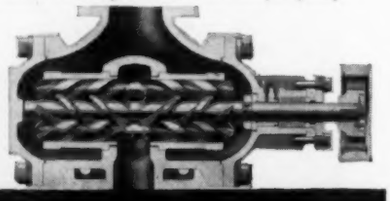
MERCO NORDSTROM VALVE CO.

A Subsidiary of Pittsburgh Equitable Meter Co.
Main Office: 400 Lexington Avenue, Pittsburgh 8, Pa.
Branch in Principal Cities

IMO OIL PUMPS
for
BATTLE Dependability

On fighting ships, where reliability and dependability under strain are all important and where space is at a premium, many thousand IMO oil pumps are in use pumping fuel oil, circulating lubricating oils, and operating hydraulic machinery. The simplicity of construction and operation that makes the IMO Pump so dependable in battle assures the commercial user of long life and trouble-free operation. This unique pump has practically nothing to get out of order; it has only three moving parts, and no pilot gears or valves. *Write for Leaflet 1-117.*

A cruiser of the U. S. Navy, one of the classes of ships equipped with De Laval-IMO oil pumps.



IMO PUMP DIVISION
of the De Laval Steam Turbine Company, Trenton 2, N. J.

LOFTUS ENGINEERING
corporation
1620 OLIVER BUILDING PITTSBURGH, PA.
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Engineers — Consultants — Contractors
Designers and Builders
of
MELTING • HEATING AND
INDUSTRIAL FURNACES

n·B·M BRONZE AND COPPER CASTINGS
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NATIONAL BEARING METALS CORP.
ST. LOUIS • PITTSBURGH • NEW YORK

negie Institute of Technology, Mr. Smith has been connected with the Worthington organization since 1923, except for a period of three years, 1933-36, when he was vice-president and general manager of the American Natural Gas Company of Shamrock, Texas.

For the past four years Mr. Smith has been manager of Worthington's Tulsa district office, as well as southwestern manager of the engine sales division.

In his new capacity, Mr. Smith will supervise the corporation's business in the southwest, where the oil and gas industries are large users of its products.

Eugene J. Reardon has been named chief engineer of the American Steel and Wire Company to succeed **George H. Rose.**

EUGENE J. REARDON

Born in Middlefield, Connecticut, Mr. Reardon was educated in the public schools of New Haven, Connecticut, before entering North Eastern University where he studied metallurgical engineering. He worked as a draftsman at the Geometric Tool Company and the Winchester Repeating Arms Company, both of New Haven, and the Lane Construction Company, at Gilboa, New York, before joining American Steel and Wire Company as a machinist at the New Haven, Connecticut Works in June, 1922. Mr. Reardon held a number of positions in New Haven before being transferred to Worcester, Massachusetts, as tramway engineer in April, 1930. In August, 1936, he was appointed superintendent of the New Haven plant and two years later was named general superintendent of the New Haven and Trenton, New Jersey plants. Since January, 1942, he has been assistant chief engineer of the wire company.

O. J. Leone has been appointed Pittsburgh regional manager of steel mill division for The Bristol Company, Waterbury, Connecticut. Mr. Leone's duties in his new position will include special engineering work in connection with the application of the company's line of steel mill instruments.

Mr. Leone was graduated from Carnegie Institute of Technology with a degree of B.S. in mechanical engi-

neering in 1937, after taking special courses in steel mill operation. In addition to the regular course he studied foundry and machine shop practice and steel making.

Previous to graduation from college Mr. Leone was employed by the Bacharach Industrial Instrument Company. In 1929 he accepted a position with Carnegie-

O. J. LEONE

Illinois Steel Corporation, Homestead Works, to become assistant special engineer doing special engineering work in connection with fuel combustion and instrument application. He continued this work for eight years and at the same time attended college.

Mr. Leone joined The Bristol Company in 1937 as sales engineer with headquarters in Pittsburgh. He will continue to maintain headquarters at the Pittsburgh branch office of The Bristol Company, 210 E. Parkway, Pittsburgh 12, Pennsylvania. His territory will include the Pittsburgh, Buffalo and Cleveland areas.

James F. Reid, former deputy chief of the alloy steel branch of the War Production Board, has been appointed production manager of The Timken Roller Bearing Company of Canton, Ohio. Mr. Reid had been production manager of the steel and tube division of the Timken Company before obtaining a leave of absence in May, 1942 to join WPB as chief of the alloy steel section. His activities and responsibilities in this new capacity extend to all divisions of the company.

Mr. Reid first joined the Timken Company twenty-five years ago as an employee in the production department, becoming, ten years later, production manager of the steel and tube division.

Born in Motherwell, Scotland, he was made a U. S. citizen upon his honorable discharge from the American Army at the end of the first World War.

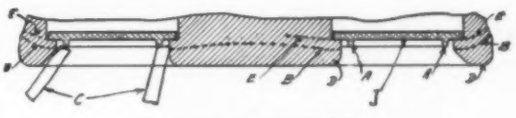
L. A. Watson recently was named vice-president in charge of engineering, development, and research, Clark Controller Company, Cleveland, Ohio.

John A. Cortelli will be chief engineer in charge of commercial engineering and of the drafting department.

Ohio Magnet Outer Rings Seldom Break

The bottom or wearing face of an Ohio Magnet presents a solid long lived surface to the work.

The annular rings on the manganese bottom plate prevent dangerous wear of steel pole shoes, so bottom plate cannot sag. See cut below.



Note wear line B B B

There are no holes or depressions to start wear or cracks.

These features result in

LOW MAINTENANCE COST.

OHIO reliable MAGNETS

The OHIO Electric Mfg. Company

5907 Maurice Avenue

Cleveland 4 · · Ohio

Lauson Stone was elected chairman of the board as well as president of the Follansbee Steel Corporation.

John Follansbee, former chairman of the board, will continue as a member of the board of directors and will be available for consultation by the corporation.

Mr. Follansbee has been associated with this and predecessor companies for approximately fifty years. He began his career with the firm of James B. Scott and Company, of which B. G. Follansbee and William U. Follansbee, his elder brothers, were members.

Subsequently, with the organization of the Follansbee Brothers Company in 1894, he became a salesman for this company, then general manager of sales, then vice-president in charge of sales in 1916, and in 1918 was elected to the board.

In 1927 Mr. Follansbee became president of the company, in which post he continued up to 1940. He also served as one of three trustees in the reorganization proceedings between 1934 and 1940. When in 1940 Follansbee Brothers Company was reorganized as the Follansbee Steel Corporation, he became chairman of the board of the new corporation.

In 1906 Mr. Follansbee was instrumental in forming the Sheet Metal Specialty Company. He has been president of this company from its beginning.

John Avery has been appointed manager of the Allis-Chalmers blower and compressor department to succeed **G. L. Kollberg.** Mr. Kollberg, who is retiring after 47 years of service with Allis-Chalmers, will continue with the company as consultant and adviser on the engineering matters.

Mr. Avery has been assistant manager of the blower and compressor department since 1935. He came to Allis-Chalmers in 1931 when the company assumed American interests of the Brown-Boveri Company. Prior to his association with the American Brown-Boveri Company, he had been with the General Electric Company and with Brown-Boveri in Switzerland.

Mr. Kollberg was born in Sweden, receiving his early technical training there. He entered the employ of the Fraser and Chalmers Company, an Allis-Chalmers predecessor, in 1897 in Chicago and came to Milwaukee when the Allis-Chalmers Company was formed.

Dr. Laurence C. Hicks, who has been in the Allegheny Ludlum Steel Corporation's research department since 1933, has been appointed metallurgical engineer and associate director of research in the magnetic products division.

Dr. Hicks, who is stationed at the company's research laboratory at Brackenridge, Pennsylvania, is a native of Denver, Colorado. He was graduated from Williams College, Williamstown, Massachusetts, in 1928. He was awarded a master's degree in metallurgy in post graduate work at Massachusetts Institute of Technology in 1931. He held an honorary fellowship in metallurgy at M. I. T. in 1932, and was conferred with the degree of doctor of science in metallurgy there in 1933.

R. H. Thielemann has been appointed development engineer for the Allegheny Ludlum Steel Corporation. Mr. Thielemann was formerly associated with the research laboratory of the General Electric Company at Schenectady, New York.

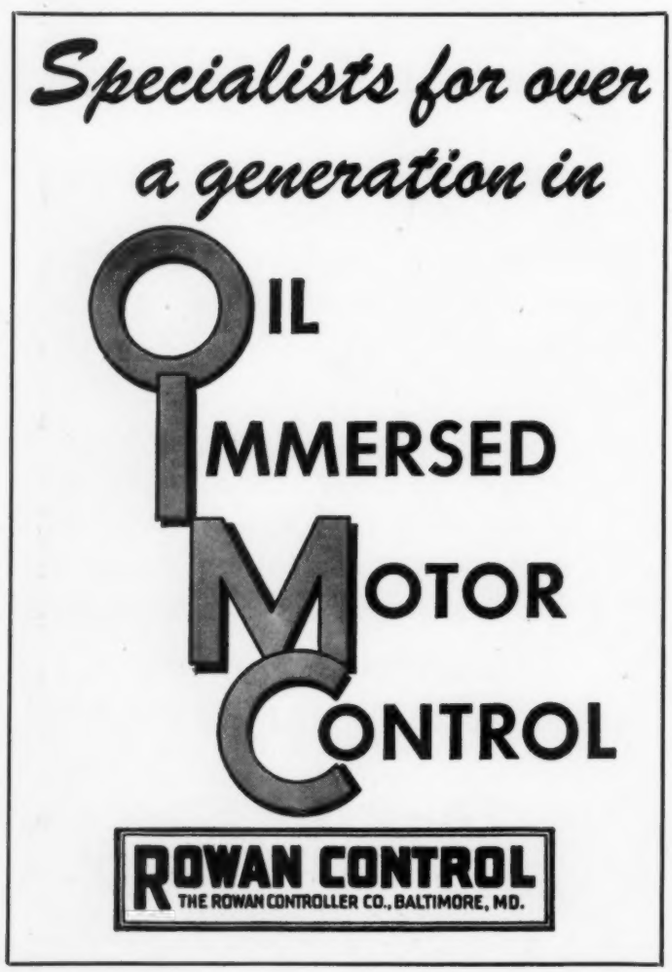
A native of Portland, Oregon, where he was born October 6, 1912, Mr. Thielemann was graduated from Oregon State College with degrees of bachelor of science in electrical engineering and master of science in mechanical engineering.

After serving as a student engineer of the Bethlehem Steel Company at their Pacific coast plants, Mr. Thielemann joined the General Electric Company in 1936, working in the turbine department. He was transferred to the metallurgical section in the research laboratory in 1937.

Fred H. Haggerson, vice-president and director, was elected president of Union Carbide and Carbon Corporation, succeeding **Benjamin O'Shea** who has been president since 1941 and now becomes chairman of the board. Mr. Haggerson has been associated with Union Carbide and Carbon Corporation for 25 years.

Dr. William A. Pennington has been appointed to the research staff of the engineering division, Carrier Corporation, Syracuse, New York.

A native of Halls, Tennessee, Dr. Pennington took his B.S. in chemistry at Union University, Jackson, Tennessee, in 1925, subsequently becoming head of the mathematics department there. Iowa State College granted him a Ph.D. degree in chemistry in 1933, after which he joined the research department of the American Rolling Mill Company.



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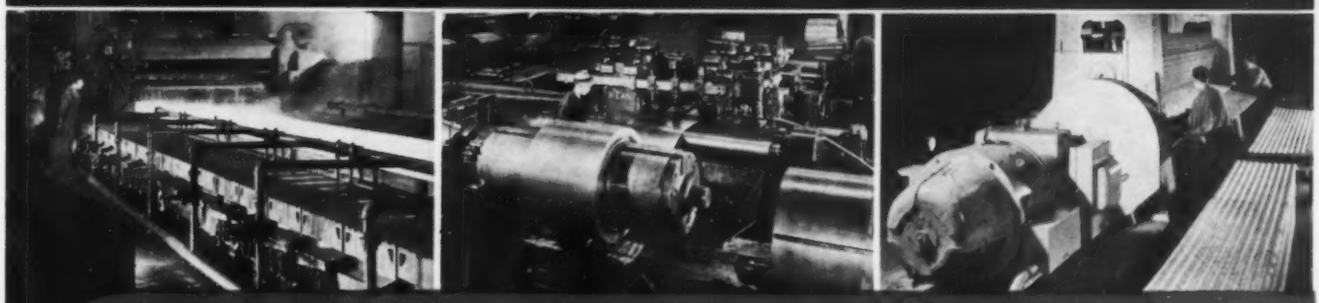

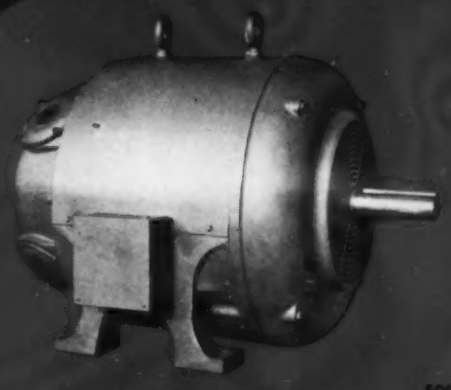

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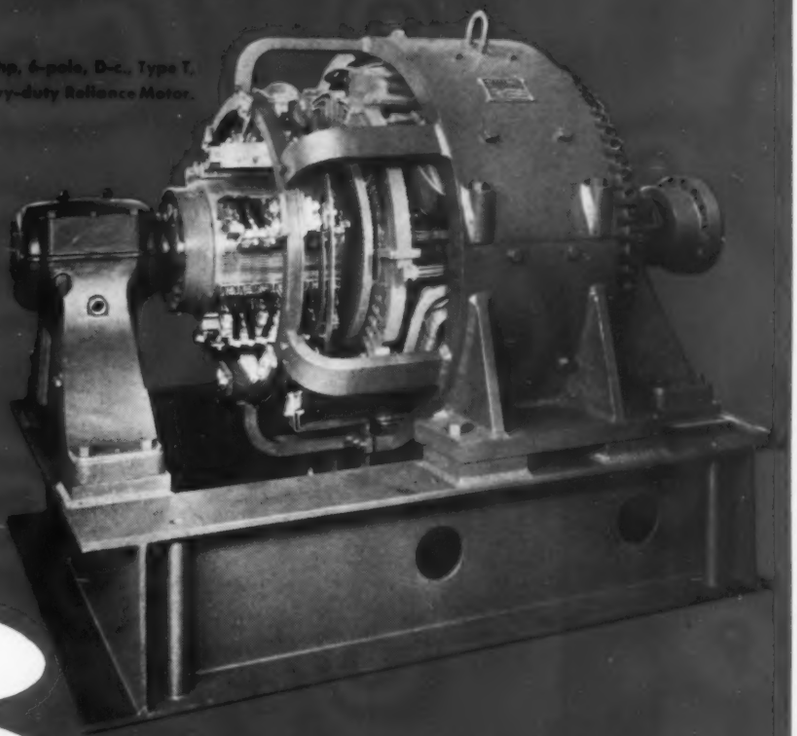

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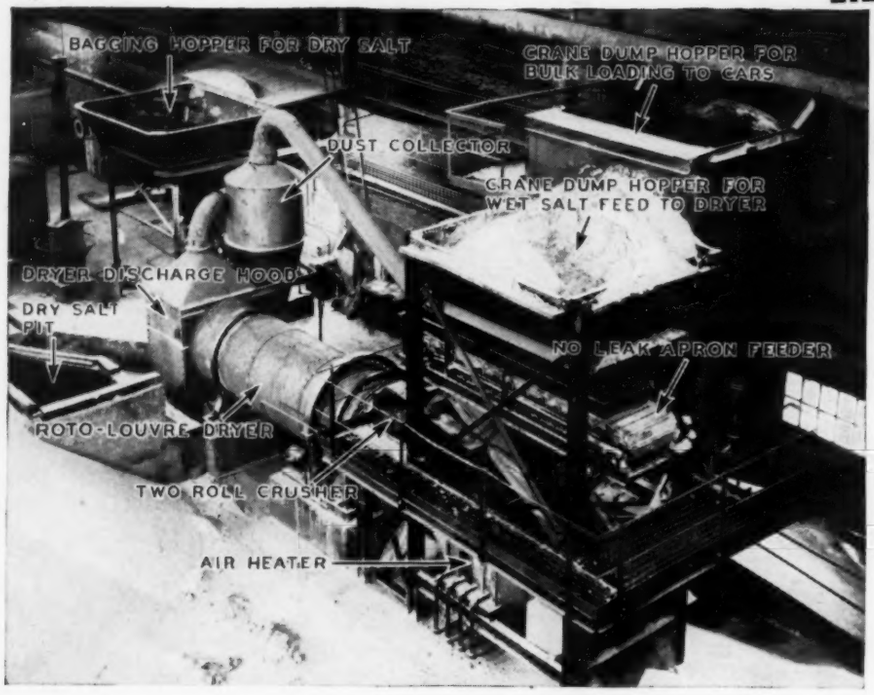
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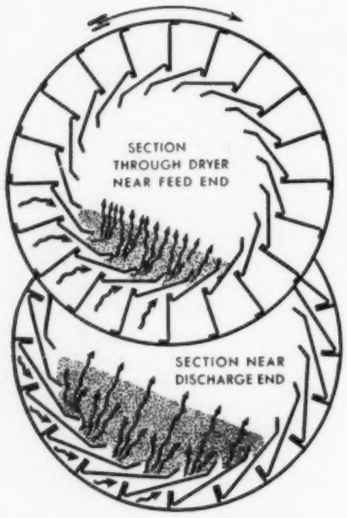
DRYER DISCHARGE HOOD
DRY SALT PIT
NO LEAK APRON FEEDER
ROTO-LOUVRE DRYER
TWO ROLL CRUSHER
AIR HEATER

This illustration shows a Roto-Louvre Dryer installation drying ammonium sulphate in a midwestern steel mill. Salt is delivered by crane to dump hopper. A 36" wide, No-Leak apron feeder assures efficient handling of the wet salt to crusher. The dryer has an output rating of 4 tons per hour. It is equipped with a rotary screen to scalp off small hardened pellets passed by the crusher. Dry salt is handled by screw conveyor from discharge hood and dust collector into the dry salt pit from where it is picked up by clam-shell for delivery to bagging hopper, bulk loading conveyor, or to temporary ground storage.



A large volume of dry hot air easily penetrates the relatively thin bed of material near the feed end of the dryer for maximum heat transfer where greatest evaporation can take place. As the material moves forward the bed becomes thicker and the air passages get smaller so that a reduced volume of heated air will penetrate the bed—thus preventing overheating.

1. Applies greatest heat volume at the start, where moisture is highest.
2. Gently mixes the material—no sliding to cause excessive wear—minimum degradation of crystals.
3. All heated air entering the dryer must come in intimate contact with the product.
4. Thorough, uniform drying to less than 0.1% in a single pass is assured without overheating.
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6. And it does all these things in the least possible floor space, and at lowest cost.

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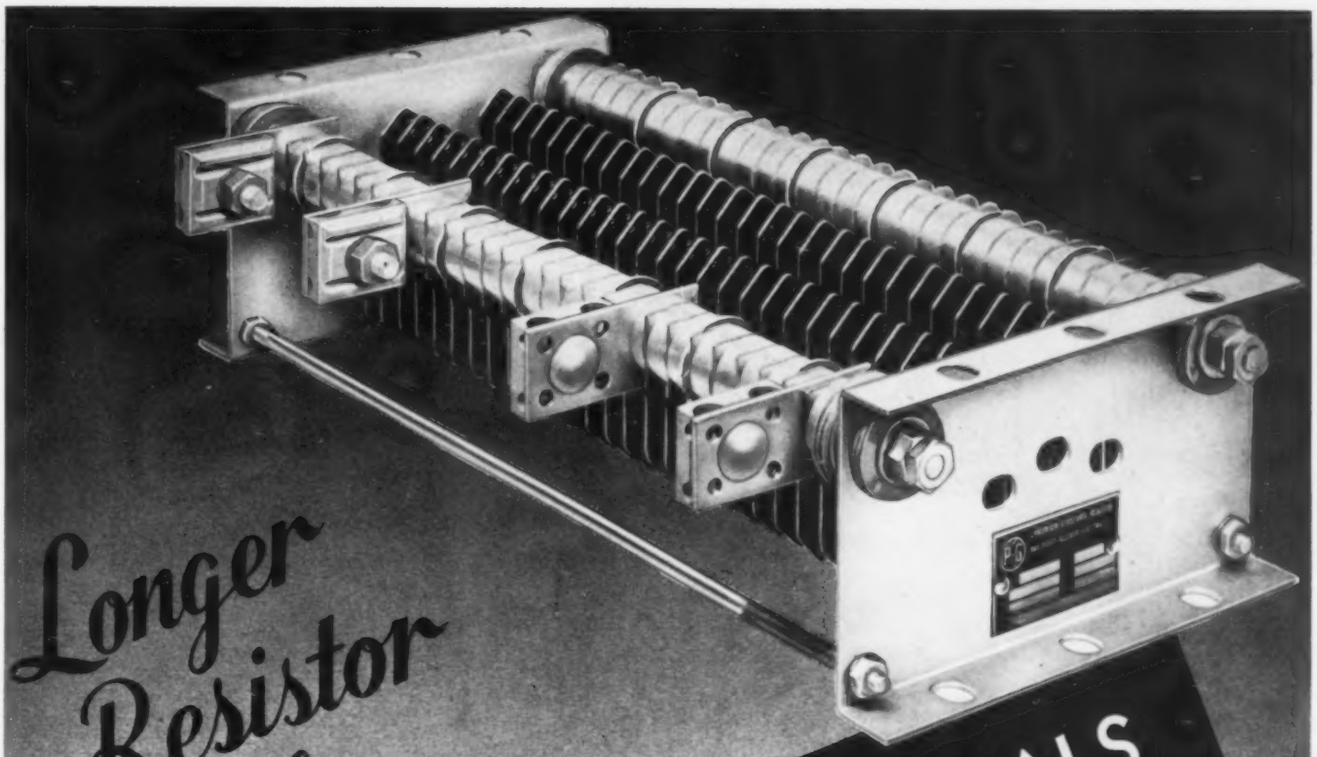

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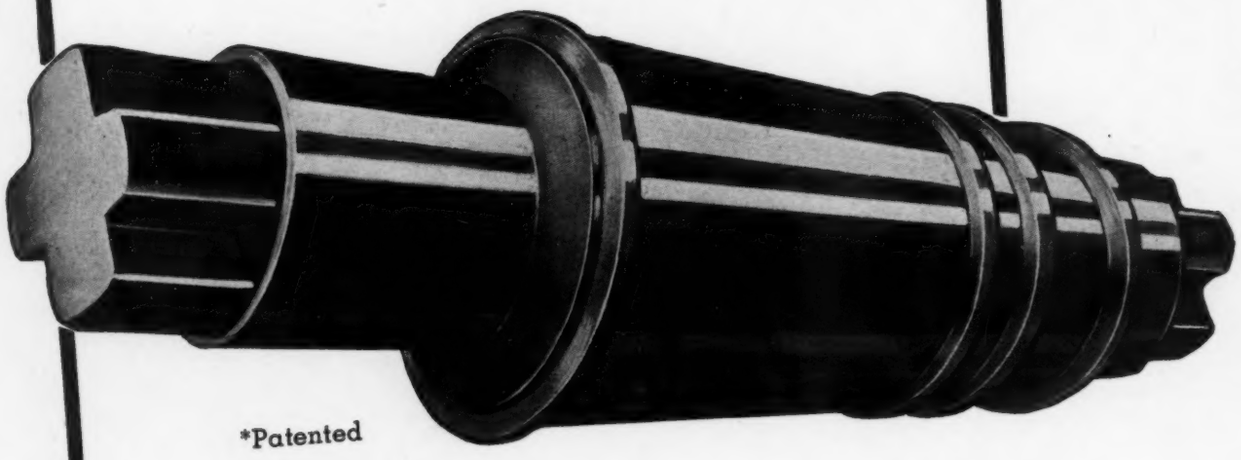

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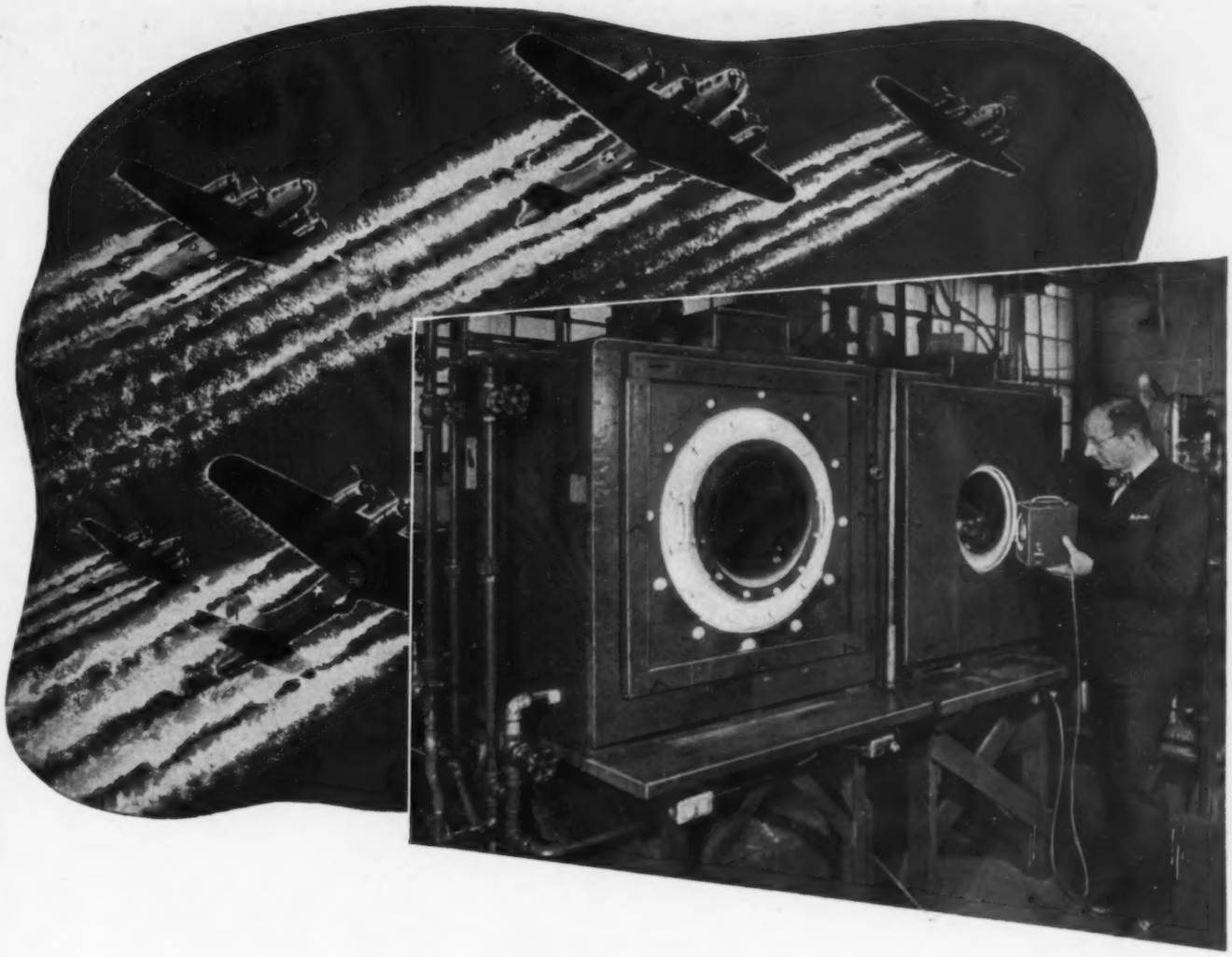

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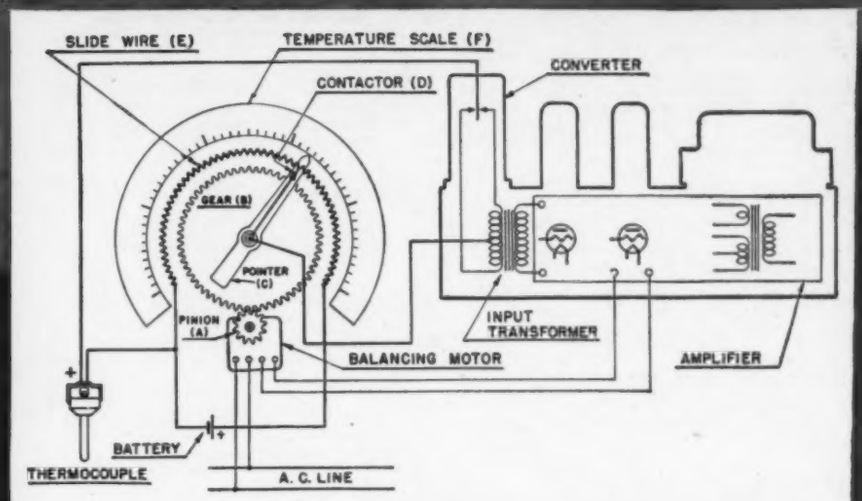

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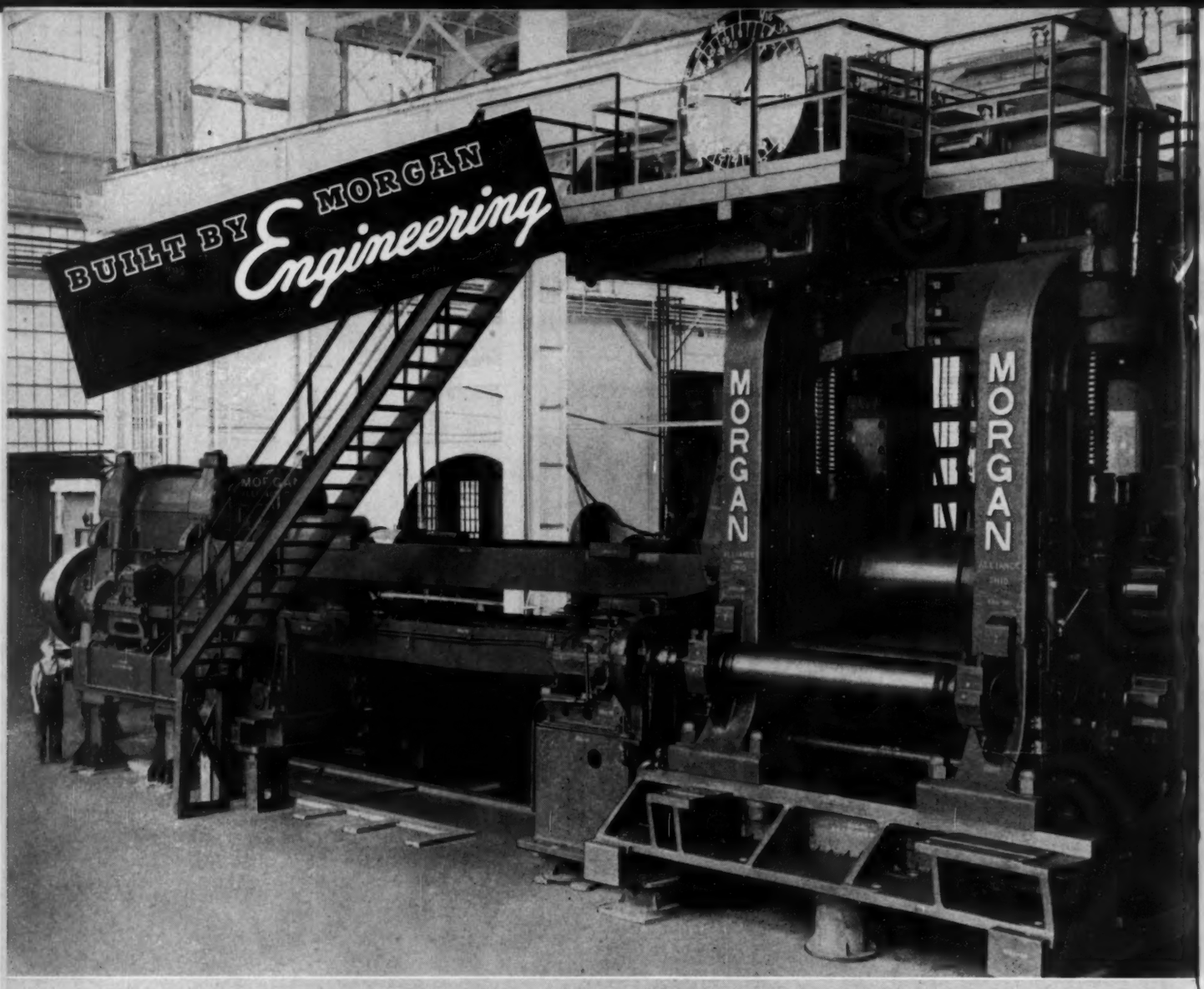

MORGAN "36" TWO-HIGH BLOOMING MILL

Above is shown a Morgan 36" Two-High Blooming Mill on erecting floor. Housings are one piece steel castings of the closed top type. Top roll balance is of the counterweight type. Top roll lift sufficient for rolling 42" wide slabs. Manipulator is of the overhead type, compact and accessible. Tables are of heavy design, equipped with anti-friction bearings.

With this Mill was furnished Auxiliary Equipment as follows — Front and Rear Tables with Manipulator — Approach Table — Ingot Buggy — Runout Tables — Slab Shear with Gauge — Crop Hoist — Pushers — Conveyor — Skid Bed and Furnace Tables.

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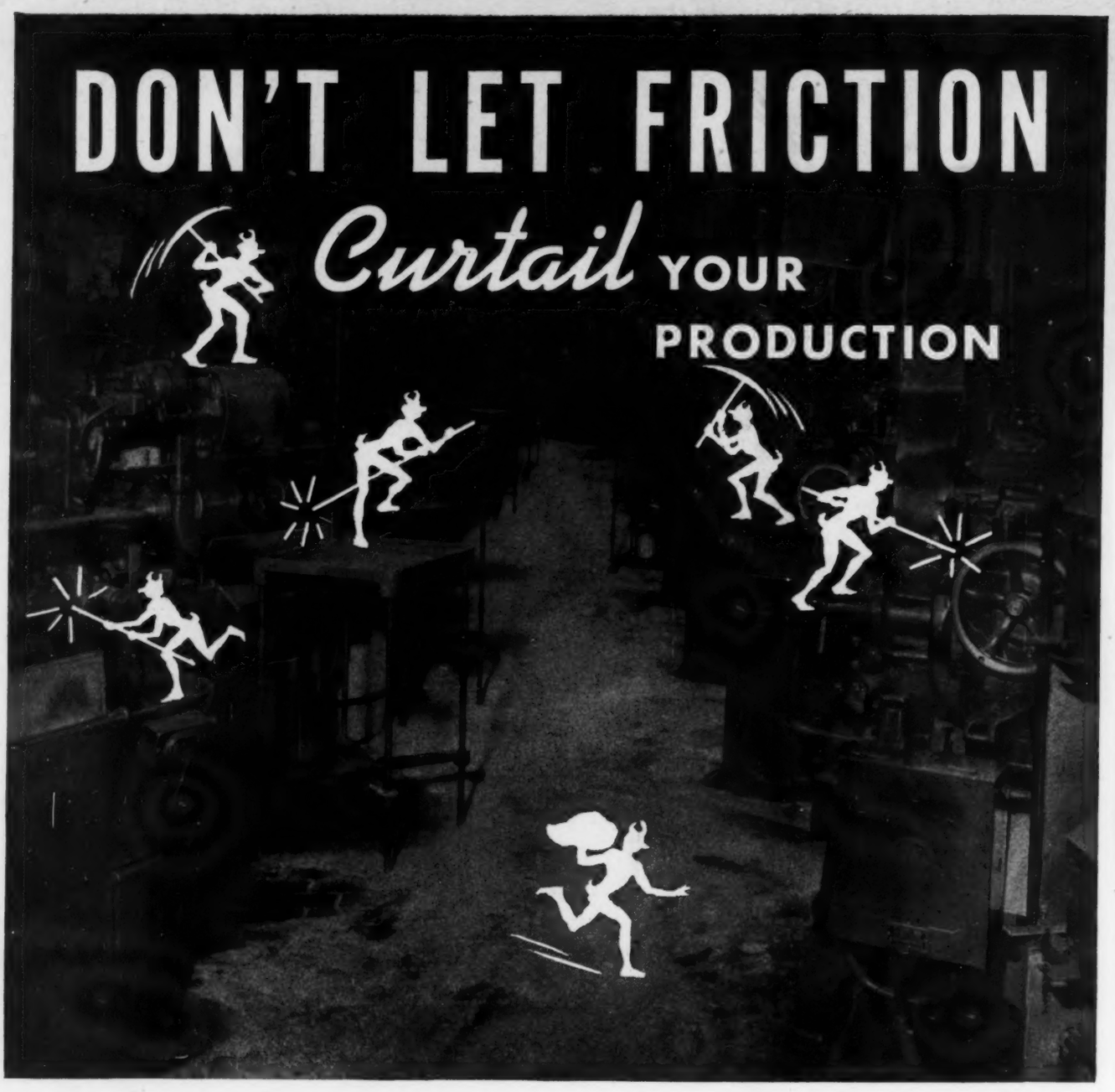
DON'T LET FRICTION *Curtail* YOUR PRODUCTION



In the high-speed drive for Victory, FRICTION finds its greatest opportunity. Machine operators have rest intervals, but the machines themselves have none. And so, normal inspections and adjustments may be overlooked—lubrication may be neglected—a bearing becomes dry or dirty, and over-heated—FRICTION'S agents get in their deadly work—and A DAMAGED, BURNED-OUT OR RUINED BEARING CRIPPLES A VITAL TOOL.

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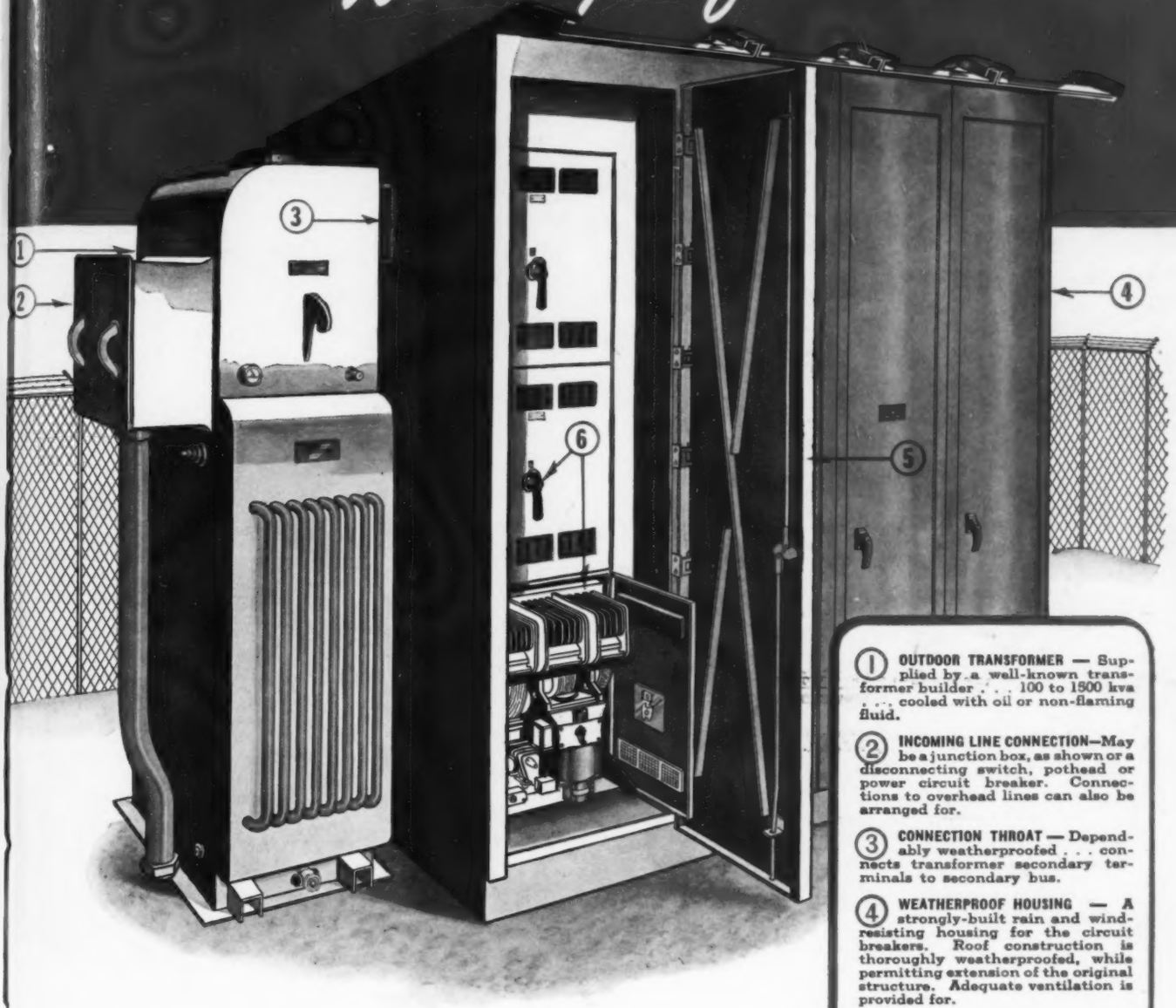

① **OUTDOOR TRANSFORMER** — Supplied by a well-known transformer builder . . . 100 to 1500 kva . . . cooled with oil or non-flaming fluid.

② **INCOMING LINE CONNECTION**—May be a junction box, as shown or a disconnecting switch, pothead or power circuit breaker. Connections to overhead lines can also be arranged for.

③ **CONNECTION THROAT** — Dependably weatherproofed . . . connects transformer secondary terminals to secondary bus.

④ **WEATHERPROOF HOUSING** — A strongly-built rain and wind-resisting housing for the circuit breakers. Roof construction is thoroughly weatherproofed, while permitting extension of the original structure. Adequate ventilation is provided for.

⑤ **FULL-LENGTH DOORS** — Three-point latches, stiffening braces, flanged edges and concealed adjustable hinges are furnished. Provision can be made for locking the doors when closed.

⑥ **CIRCUIT BREAKERS** — Drawout type, manually or electrically operated . . . current and interrupting rating to suit your requirements. Each breaker is protected by a hinged door with ventilating louvers and may be operated manually without opening door. In capacities up to 1600 amperes, the circuit breakers are mounted three-high as shown. A wide range of protective devices is available to guard against overcurrent, short circuits, low voltage and other abnormal conditions.

No brick and mortar structure to build, since I-T-E Weatherproof Switchgear can safely be placed anywhere outdoors. By choosing a location close to the plant area where power is used, cables for low-voltage current can be short. These are savings. Add to them the provisions I-T-E makes for long service life under outdoor conditions—tightness of welded-steel structures, the protection qualities of I-T-E finish, the durable circuit breakers capable of performing with minimum of maintenance. Let I-T-E engineers give you the cost figures of outdoor substations in accordance with your specifications. For complete information, get in touch with the I-T-E representative nearest you, or write I-T-E Circuit Breaker Company, 19th & Hamilton Sts., Philadelphia 30, Pa.

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G-E amplidynes give smoother and simpler reversing-mill control

A score or more of reversing mills are now demonstrating *conclusively* the practical advantages of amplidyne control. These mills range up to 10,000 hp in size; some of them are twin-drives. They include blooming mills, slabbing mills, plate mills, hot aluminum and copper mills, and other types. In these applications, the amplidyne:

1. Has made it possible to replace heavy-current-carrying contactors with small relays handling fractions of an ampere.

2. Has reduced the number of control devices some 50 per cent.

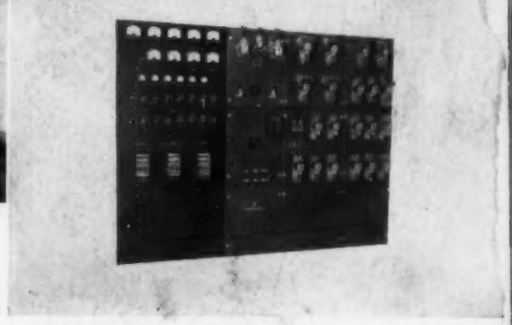
3. Makes possible smoother, more accurately controlled acceleration and deceleration.

4. Provides effective load-limit control, making maximum torque quickly available for heavy passes.

5. Automatically supplies voltage regulation for the generators.

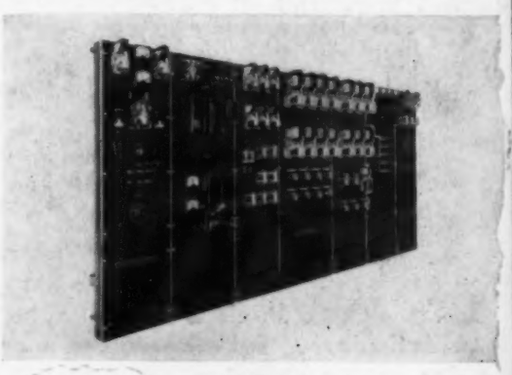
Reversing mills are but one type of metal-mill application where amplidynes have boosted output, simplified maintenance, and paved the way for better control of product quality. Strip mills, tin-plating lines, induction furnaces, tension reels, and flying shears are a few others.

A variety of amplidyne circuit diagrams and an illustrated description of how the amplidyne works are available in Bulletin GEA-4053. May we send your copy? *General Electric Company, Schenectady 5, N. Y.*



NOW

With amplidyne control, a modern blooming mill requires a panel like this. Note the small, multi-circuit relays used in place of the heavy-current-carrying contactors formerly required



THEN

Before the advent of amplidyne control, a similar mill required a panel like this. Note the size and number of devices to be maintained in service.

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